Comparison between three glass fiber post cementation techniques

Guido Migliau MD, DDS, PhD[1]
Luca Piccoli DDS, PhD[1]
Stefano Di Carlo MD, DDS, PhD[1]
Giorgio Pompa MD, DDS, PhD[1]
Laith Konstantinos Besharat DDS, MsC, PhD[1]
Marco Dolci MD, DDS, PhD[2]

[1] Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome, Rome, Italy
[2] Department of Medical, Oral and Biotechnological Sciences, "G. D'Annunzio" University of Chieti, Chieti, Italy

Corresponding author:
Laith Konstantinos Besharat
Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome,
Via Caserta 6
00161 Rome, Italy
E-mail: besharatlk84@yahoo.it

Summary

***Objective*. The aim of this experimental study was to compare the traditional cement systems with those of the latest generation, to assess if indeed these could represent of viable substitutes in the cementation of indirect restorations, and in the specific case of endodontic posts.**
***Methods*. The assessment of the validity of the cementing methods was performed according to the test of the push-out, conducted on sections obtained from the roots of treated teeth. The samples were divided into three groups. Group A (10 samples): etching for 30 seconds with 37% orthophosphoric acid (Superlux-Thixo-etch-DMG) combined with a dual-curing adhesive system (LuxaBond-Total Etch-DMG), dual-cured resin-composite cement (LuxaCore-DMG) and glass fiber posts (LuxaPost-DMG). Group B (10 samples): self-adhesive resin cement (Breeze-Pentron Clinical) and glass fiber posts (LuxaPost-DMG). Group C (10 samples): 3 steps light-curing, self-etching, self-conditioning bonding agent (Contax-Total-etch-DMG), dual-cured resin-composite cement (LuxaCore-DMG) and glass fiber posts (LuxaPost-DMG). The survey was conducted by examining the breaking resistance of the post-cement-tooth complex, subjected to a mechanical force. Statistical analysis was performed using SPSS Inc. ver. 13.0, Chicago, IL, USA.**
***Results*. Group A values of bond strenth ranged from a minimum of 10.14 Mpa to a maximum value of 14.73 Mpa with a mean value of 12.58 Mpa. In Group B the highest value of bond strength was 6.54 Mpa and the minimum 5.55 Mpa. The mean value of the bond strength for the entire group was 6.58 Mpa. In Group C the highest bond strength was 6.59 Mpa whereas the lowest bond strength was 4.84 Mpa. Mean value of the bond strength of Group C was calculated at 5.7 Mpa.**
***Conclusions*. Etching with orthophosphoric acid combined with a dual-curing adhesive system and a dual-cured resin-composite cement was the technique that guaranteed the highest bond strength. Lowest bond strength values were obtained when dual self-adhesive cement was used.**

Key words: glass fiber post, self-adhesive cement, etching.

Introduction

For a complete understanding of the several aspects of adhesion, it is fundamental to know and recognize the substrates the materials work on. Enamel, dentin and cementum represent very different adhesive surfaces due to their composition, morphology and biomechanical characteristics. The adhesion obtained through the adhesive systems is both chemical and especially micro-mechanical, with the formation of the hybrid layer and resin tags, which are achieved through the etching time: it increases the available surface and, consequently, the contact with the resin. All the above remarks hold true in the restoration of endodontically treated teeth, as well. In this sort of teeth, the substrate with which the adhesion is obtained is basically the dentin, at both a pulp chamber and root canal. Post cementation is a delicate procedure where the cement must have the ability to bond (1-7) to three different surfaces; the post, the dental tissue and the restorative material. In detail two different types of cementation can be described. Firstly, the standard classical cementing procedure that includes the use of adhesive systems (8, 9) and resin composite cements combined with etching pretreatment of the tooth surface. Secondly, the last generation cementing involves the use of self-etching composite cements. These cements are introduced directly into the root canal (10-14) without having to use any adhesive system beforehand, since they contain components that allow the enclosure of the adhesion procedure in one step and therefore simplifying and significantly reducing the operative time.

Experimental Analysis

Objective of the study

The aim of this experimental study was to compare the traditional cement systems with the cement systems of the latest generation, to assess if indeed the latest generation could represent viable substitutes in the cementation of indirect restorations (15, 16), and in the specific case of endodontic posts.

The non-metallic posts had several advantages compared to the metallic ones, such as the realization of a homogeneous tooth-reconstruction system (17, 18), the low cost, the easy usage and a vast field of application; reasons that favored the selection of the fiber-glass posts (LuxaPost-DMG) for this study.

The assessment of the validity of the cementing methods was performed according to the push-out test, conducted on sections obtained from the roots of treated teeth and performed at the Department of Biomedicine at the University of Trieste.

Material and Methods

Comparison of the retentive efficiency (19, 20) of three different types of cementation using the same type of post (LuxaPost-DMG) was performed for all samples. The survey was conducted by examining the breaking resistance of the post-cement-tooth complex, subjected to a mechanical force.

The following products were used in our sample preparation:

- a dual-curing adhesive system (LuxaBond-Total Etch-DMG)
- phosphoric acid at 37% (Superlux-Thixo-etch-DMG)
- conventional dual-cured resin-composite cement (LuxaCore-DMG)
- dual self adhesive cement (Breeze-Pentron Clinic)
- a 3 steps light-curing, self-etching, self-conditioning bonding agent (Contax-Total-etch-DMG)
- fiber posts (LuxaPost-DMG).

Sample preparation

We examined 30 roots of monoradicular teeth, extracted for periodontal reasons and stored in water.

The applied protocol concerning the preparation of the root canal filling and post-space is described below.

All samples were prepared using the simultaneous technique with NiTi M2 instruments (Sweden & Martina) with the following sequence: 10/taper 4% - 15/taper 5% - 20/taper 6% - 25/taper 6%. Irrigation, during preparation, was performed by the use of sodium hypochlorite at 5% (Niclor5, Ogna), with a final wash (for 2 minutes) with the same product at 37 °C. The root canal filling was carried out with cold lateral condensation technique with ISO standardized gutta-percha cones and cement containing epoxy resin Top Seal (Dentsplay, Maillefer). Preparation of the post space was carried out with Largo 1 and 2 burs (Dentsplay, Maillefer) at the length of 10 mm for each sample.

The samples were then divided into 3 groups:

- group A (10 samples): etching for 30 seconds with 37% orthophosphoric acid (Superlux-Thixo-etch-DMG) combined with a dual-curing adhesive system (LuxaBond-Total Etch-DMG), dual-cured resin-composite cement (LuxaCore-DMG) and glass fiber posts (LuxaPost-DMG)
- group B (10 samples): self-adhesive resin cement (Breeze-Pentron Clinical) and glass fiber posts (LuxaPost-DMG)
- group C (10 samples): 3 steps light-curing, self-etching, self-conditioning bonding agent (Contax-Total-etch-DMG), dual-cured resin-composite cement (LuxaCore-DMG) and glass fiber posts (LuxaPost-DMG).

Preparation of the samples for the mechanical test

The portion of each root corresponding to the bonded fiber post was transversally sectioned into 1mm-thick serial slices, using a microtome (Micormet-Remet) posting a low speed saw (Norton-Dia Wheel), 0.2 mm thick, under water-cooling operating at 2.240 spins per minute. The sections were realized in apical-coronal direction and each section was marked on the apical surface to put it exactly under the punch of the machine for the push-out test. A number was assigned to each root and a progressive alphabetical letter to each slice from the apical surface to the coronal one (Fig. 1).

The push-out test

Push-out load was applied using a universal testing machine Galdabini-Sun 500 at a crosshead speed of 0.5 mm/min to obtain the extrusion of the post. The punch was positioned to touch the post only, without stressing the surrounding dentinal walls. The load was applied on the apical surface of the slice in apical-coronal direction, with the purpose of preventing the conical shape of the canal from withstanding the dislodgment of the post. Push-out strength data was calculated in Newtons (N), which was converted to MegaPascals (Mpa) by dividing the load by the bonded surface area. In order to obtain the bonded surface area of each sample, we took pictures of the apical surface using an optical microscope (Zeiss laser scan). We used for each picture the same angle of view and enlargement (50x) after the Push-out test (Fig. 2).

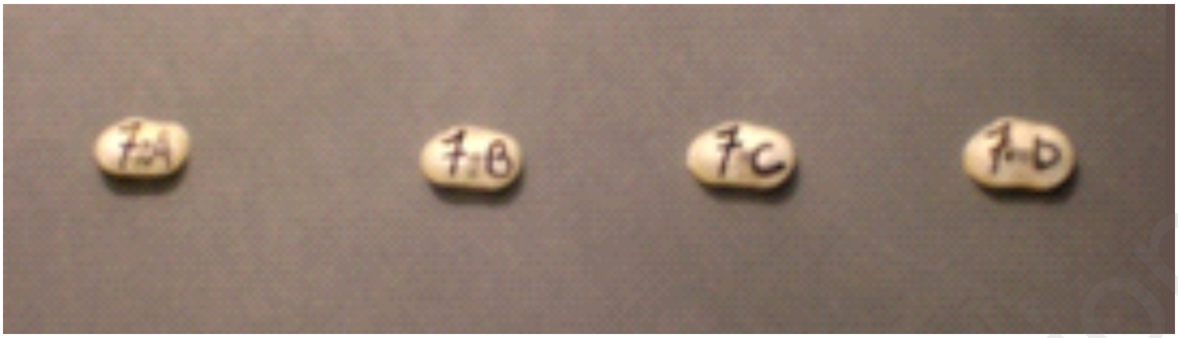

Figure 1. Marked slices after sectioned.

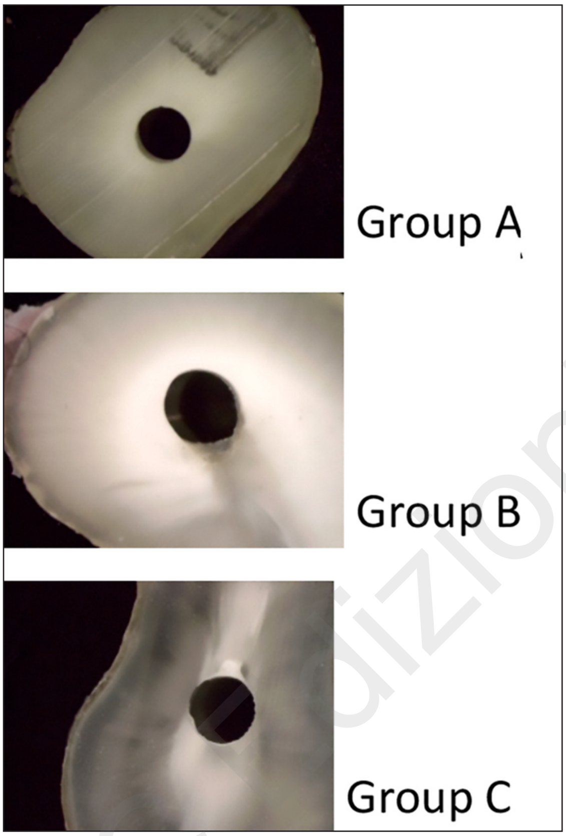

Figure 2. Pictures obtained with the optical microscope after the push-out test.

Similarly a picture of a marked size (1 mm) was taken. Image processing software provided with the optical microscope was used to analyze the pictures after calibrating the space using the marked size. The visible circumference size was found, following the line of the fracture. Knowing the thickness of the sample (1 mm) and the taper of the apical surface of the post, we calculated the lateral surface area of a truncated cone which is the bonded surface area through the formula:

$$S_L = \pi\left(R + r\right)\left[(h^2 + (R - r)^2\right]^{0.5}$$

Where R is the coronal post radius, r the apical post radius, and h the thickness of the slice.
Each slice was submitted to the same procedure.
Statistical analysis was performed using SPSS Inc. ver. 13.0, Chicago, IL, USA. Chi-squared test was used for statistical evaluation of proportions. In cases of more than 2 independent means we used the ANOVA test. A p-value of less than 0.05 was considered significant. A 95% CI was used in all analysis. In order to assure data reliability, data were entered in two different personal computers by two examiners; the two data files were compared in order to detect entry errors. The two files resulted identical.

Results

For each analyzed section we obtained the bond strength between the post and the dentin (MPa). Results were analyzed using the ANOVA test.
For the samples of the group A the values of the various samples ranged from a minimum value of 10.14 Mpa for the slice A6 to a maximum value of 14.73 Mpa for the A1 sample with a mean value of 12.58 Mpa.
In group B the highest value of bond strength was reported in the B1 slice with 6.54 Mpa and the minimum at the B8 with 5.55 Mpa. The mean value of the bond strength for the entire group was 6.58 Mpa.
Finally, in group C the highest bond strength was reported at the C6 slice with 6.59 Mpa whereas the lowest bond strength was reported at the C2 slice with 4.84 Mpa. Mean value of the group C was calculated at 5.7 Mpa. (Tab. 1).
The results obtained are reported in the Table 1 below.

Discussion

In this study, we show that the adhesion force is greater for the group A, differences are statistically significant when group A is compared to group B and group C. Moreover, highest bond strength values obtained in group B compared to group C aren't statistically significant. Lowest bond strength values were obtained where the etching step wasn't performed. Our results can be useful for comparison with recent

Tabella 1. Results obtained after the push-out test.

Group A	samples	Mpa	Group B	samples	Mpa	Group C	samples	Mpa
A1	4	14.73	B1	5	7.54	C1	6	6.04
A2	5	12.98	B2	4	6.58	C2	5	4.84
A3	5	12.01	B3	4	5.95	C3	4	5.75
A4	5	13.47	B4	5	6.6	C5	5	5.91
A5	5	11.25	B5	5	7.07	C5	6	4.97
A6	5	10.14	B6	5	6.73	C6	6	6.59
A7	5	14.5	B7	6	6.8	C7	5	6.39
A8	6	14.23	B8	5	5.55	C8	6	6.07
A9	5	11.33	B9	5	7.41	C9	5	5.33
A10	5	11.2	B10	5	5.91	C10	5	5.58
		Mean 12.58			Mean 6.58			Mean 5.7

similar studies (21). Etching with orthophosphoric acid combined with a dual-curing adhesive system and a dual-cured resin-composite cement is the technique that guarantees a satisfying bond strength, a dual self adhesive cement could be used in situations in our daily clinical practice where the patient doesn't fully collaborate and we have to diminish execution time and simplify the post cementation procedure.
Further studies need to be carried out on this issue taking into account new dual self-adhesive cements that will be launched next year from several multinational dental companies such as 3M and Kerr.

References

1. Abu-Hanna A, Gordan VV, Mjor I. The effect of variation in etching times on dentin bonding. Gen Dent. 2004 Jan-Feb;52(1):28-33.
2. Migliau G, Piccoli L, Besharat LK, Di Carlo S, Pompa G. Evaluation of over-etching technique in the endodontically treated tooth restoration. Ann Stomatol (Roma). eCollection 2015 Jan-Mar. 2015 May18;6(1):10-14.
3. Ahid F, Andrade MF, Campos EA, Luscino F, Vaz LG. Influence of different dentin etching times and concentrations and air-abrasion technique on dentin microtensile bond strength. Am J Dent. 2004 Dec;17(6):447-450.
4. Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH. Microtensile bond strenght between adhesive cements and root canal dentin. Dent Mater. 2003;19(3):199-205.
5. Brajdić D, Krznarić OM, Azinović Z, Macan D, Baranović M. Influence of different etching times on dentin surface morphology. Coll Antropol. 2008 Sep;32(3):893-900.
6. Migliau G, Piccoli L, Besharat LK, Romeo U. Benchmarking matching color in composite restorations. Ann Stomatol (Roma). 2016 Jul19;7(1-2):29-37.
7. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature - Part 1. Composition and micro- and macrostructure alterations. Quintessence Int. 2007 Oct;38(9):733-743.
8. Ferrari M, Cagidiaco MC, Goracci C, Vichi A, Mason PN, Radovic I, Tay F. Long-term retrospective study of the clinical performance of fiber post. Am J Dent. 2007;20(5):287-291.
9. Ferrari M, Mannocci F, Vichi A, Cagidiaco MC, Mjör IA. Bonding to root canal: structural characteristics of the substrate. Am J Dent. 2000 Oct;13(5):255-260.
10. Hashimoto M, Ohno H, Endo K, Kaga M, Sano H, Oguchi H. The effect of hybrid layer thickness on bond strength: demineralized dentin zone of the hybrid layer. Dent Mater. 2000 Nov;16(6):406-411.
11. Hashimoto M, Ohno H, Kaga M, Sano H, Tay FR, Oguchi H, Araki Y, Kubota M. Over-etching effects on micro-tensile bond strength and failure patterns for two dentin bonding systems. J Dent. 2002 Feb-Mar;30(2-3):99-105.
12. Hayashi M, Takahashi Y, Hirai M, Iwami Y, Imazato S, Ebisu S. Effect of endodontic irrigation on bonding of resin cement to radicular dentin. Eur J Oral Sci. 2005 Feb;113(1):70-76.
13. Lopes GC, Cardoso Pde C, Vieira LC, Baratieri LN. Microtensile bond strength to root canal vs pulp chamber dentin: effect of bonding strategies. J Adhes Dent. 2004 Summer;6(2):129-3.
14. Rosella D, Rosella G, Brauner E, Papi P, Piccoli L, Pompa G. A tooth preparation technique in fixed prosthodontics for students and neophyte dentists. Ann Stomatol (Roma). 2016 Feb12;6(3-4):104-109.
15. Marshall GW Jr, Marshall SJ, Kinney JH, Balooch M. The dentin substrate: structure and properties related to bonding. J. Dent. 1997;25(6):441-458.
16. Morris MD, Lee KW, Agee KA, Bouillaguet S, Pashley DH. Effects of sodium hypochlorite and RC-Prep on bond strenghts of resin cement to endodontic surfaces. J Endod. 2001;27(12):753-757.
17. Musikant BL, Deutsch AS. Post design and his impact on the root and crown. Compend Contin Educ Dent. 2006 Feb;27 (2):130-133.
18. Migliau G, Besharat LK, Sofan AA, Sofan EA, Romeo U. Endo-restorative treatment of a severly discolored upper incisor: resolution of the “aesthetic” problem through Componeer veneering System. Ann Stomatol (Roma). 2016 Feb12;6(3-

4):113-8.eCollection 2015 Jul-Dec. Review.
19. Perdigão J, Gomes G, Augusto V. The effect of dowel space on the bond strengths of fiber posts. J Prosthodont. 2007 May-Jun;16(3):154-164.
20. Pioch T, Stotz S, Buff E, Duschner H, Staehle HJ. Influence of different etching times on hybrid layer formation and tensile bond strength. Am J Dent. 1998 Oct;11(5):202-206.
21. Durski MT, Metz MJ, Thompson JY, Mascarenhas AK, Crim GA, Vieira S, Mazur RF. Push-Out Bond Strength Evaluation of Glass Fiber Posts With Different Resin Cements and Application Techniques. Oper Dent. 2016 Jan-Feb;41(1):103-110. doi: 10.2341/14-343-L. Epub 2015 Sep 2.