ISSN 2236-8035
Archives of Oral Research, v. 7, n. 1, p. 17-26, Jan./Apr. 2011

Effect of cement type on microleakage of cast post-and-core systems under cyclic loading

Efeito do tipo de cimento na microinfiltração de núcleos metálicos fundidos submetidos à fadiga cíclica

Leyla Sadighpour[a], Maryam Memarian[b], Zohreh Moradi[c], Niloofar Goudarzi[d], Mohammad J Kharazi Fard[e]

[a] DDS, MS, associate professor, Department of Prosthodontics, Dental School, Tehran University of Medical Science, Tehran - Iran.
[b] DDS, MS, associate professor, Department of Prosthodontics, Dental School, Tehran University of Medical Sciences, Tehran - Iran, e-mail: memarian@sina.tums.ac.ir
[c] DDS, private practitioner and member of Student Research Association of Tehran University of Medical Sciences, Tehran - Iran.
[d] DDS, private practitioner and member of Student Research Association of Tehran University of Medical Sciences, Tehran - Iran.
[e] DDS, PhD graduate student, Public Health Faculty, Tehran University of Medical Sciences, Tehran - Iran

Abstract

Objective: The purpose of this study was to compare the microleakage of four cements in cast post-and-core systems under cyclic loading. **Materials and methods**: Sixty-four human premolars were sectioned at the cement-enamel junction, endodontically treated, and divided into four groups (n = 16). Cast posts and cores were fabricated for root segments and were cemented with zinc phosphate cement (Harvard), resin-modified glass ionomer (Fuji PLUS), dual-cured phosphate methacrylate resin cement (Panavia F), or a dual-cured resin cement (Variolink II). All specimens underwent thermal cycling for 1.500 cycles with 5 °C and 55 °C, with a dwelling time of 12 seconds. Half of the specimens of each group were subjected to cycling loading with 50 N at 1.2 Hz for 750,000 cycles. Specimens were then immersed in 5% basic fuchsin solution for 24 hours. Specimens were sectioned, visualized by stereomicroscope under 40x magnification and scored for dye penetration. The ratio between the length of the interface and the length of dye penetration was also determined. Microleakage differences between the four cements were analyzed by Kruskal-Wallis test, and the effect of fatigue was analyzed with Mann-Whitney nonparametric test (α =.05). **Results**: No failures occurred during fatigue testing. The zinc phosphate cement showed significantly higher microleakage values compared to other cements under both unloaded and loaded conditions (p = .007 and p = .006). Fatigue significantly increased the microleakage in all groups (p < .05). **Conclusions**: The microleakage values for the resin cements and the resin-modified glass ionomer were similar and significantly less than those of zinc phosphate, irrespective of loading. Fatigue loading increased the microleakage values for all the cements.

Keywords: Post and core. Microleakage. Cyclic loading. Thermal cycling.

Abstract

Objetivo*: O objetivo deste estudo foi comparar a microinfiltração de pinos e núcleos de preenchimento metálicos cimentados com quatro diferentes materiais.* ***Materiais e Métodos****: 64 pré-molares humanos foram seccionados na junção cemento-esmalte, tratados endodonticamente e divididos em quatro grupos (n = 16). Pinos e núcleos metálicos fundidos foram fabricados e cimentados com cimento de fosfato de zinco (Harvard), cimento de ionômero de vidro modificado (Fuji Plus), cimento resinoso dual de metacrilato fosfato (Panavia F) e cimento resinoso dual (Variolink II). Todos os espécimes foram submetidos à ciclagem térmica (1.500 ciclos a 5-55 °C, 12 segundos de banho). Metade dos espécimes de cada grupo foi submetida a uma carga cíclica de 50 N a 1,2 Hz em um total de 750.000 ciclos. Após a ciclagem, os espécimes foram imersos em solução de fucsina básica 5% por 24 horas, seccionados, visualizados sob aumento de 40x e ranqueados quanto à penetração do corante. A proporção entre o comprimento da interface e o comprimento da penetração do corante foi também determinada. As diferenças de infiltração entre os quatro cimentos foram analisadas por teste de Kruskal-Wallis e o efeito da fadiga foi analisado por teste não paramétrico de Mann-Whitney (α = 0,05).* ***Resultados****: Não ocorreram falhas durante o teste de fadiga. O cimento de fosfato de zinco mostrou valores de infiltração significativamente maiores comparados aos demais cimentos na ausência ou presença da fadiga (p = 0,007 e p = 0,006). A fadiga elevou significativamente a microinfiltração em todos os grupos (p < 0,05).* ***Conclusões****: Os valores de microinfiltração para os cimentos resinosos e para o cimento de ionômero de vidro modificado foram similares e inferiores àqueles do cimento de fosfato de zinco, independente da aplicação do teste de fadiga. A fadiga elevou os valores de microinfiltração para todos os cimentos.*

Palavras-chave*: Núcleos e pinos. Microinfiltração. Carga cíclica. Ciclagem térmica.*

Introduction

The selection of materials and type of restorations designed for pulpless teeth depends on the degree of hard tissue destruction. For severely compromised teeth, a post and core foundation is needed to retain a definitive restoration (1). Cast post and core foundations have been used for decades. They exhibit a high overall survival rate (78-94% over 17 year) (2), comparable to vital abutment tooth restorations (3). As such, cast post-and-core foundations are considered as the gold standard for the restoration of endodontically treated teeth with extensive loss of coronal tooth structure and for those requiring multiple abutment prostheses (4-7). *In vitro* studies have shown less favorable failure modes for cast posts and cores than for non-metallic alternatives (7, 8). However, in some clinical investigations retention loss was the most frequent cause of failure over an extended period of time (9).

The retention properties of posts depend on their design, length, and surface roughness, as well as on the fitting accuracy of the post and the resistance of luting agents to the dislodging forces generated during function (10-12). The mechanical retention of the post-and-core system as well as the cement properties and sealing abilities affect the microleakage between the coronal restoration and tooth (5, 13-15). Coronal leakage at the restoration margin could allow saliva or bacterial endotoxins to penetrate into the post space, resulting in recurrent caries and/or cement breakdown (1, 16).

Cement disintegration may eventually result in post dislodgement and, in certain situations, root fracture (17).

Recently, luting of metallic posts with resin cements has gained clinical interest (18, 19). Studies suggest better retention, improved chemical stability, and more favorable stress distribution for resin cements (7). These properties make them appropriate substitutes for conventional luting agents in less favorable tooth conditions, such as a short and irregular root canal anatomy or reduced tooth structure height (1, 19-23). Several studies have compared the retentive properties of luting agents with different post-and-core systems, including cast metal post-and-core (6, 11, 18, 21-23). Jung et al. (13) also investigated microleakage of cast post-and-core and other prefabricated non-metallic and stainless steel post and found the greatest microleakage when resin cement was used with a cast post-and-core. However, a study of preliminary failure and microleakage associated with fatigue loading with three types of metal posts, cast posts, and a fiber-reinforced resin post, all cemented with zinc phosphate, found no significant difference in leakage among the tested groups (24).

Until now, none previous study has addressed the microleakage of cast post-and-core systems with different cements as luting agents. It has been suggested that teeth and dental restorations are exposed to long-term, low magnitude masticatory loads that could cause fatigue failure, and that this possibility should be considered when testing restorative materials *in vitro* (25). The present study evaluated the microleakage of four types of cements used for luting cast posts and cores after thermal cycling and cyclic loading. The null hypotheses were: (1) there is no difference in the microleakage of the different cements, and (2) fatigue loading has no influence on the microleakage values for all the tested cements.

Therefore, the aim of this study was to evaluate the microleakage of four types of cements used for luting cast posts and cores after thermal cycling and cyclic loading.

Materials and method

Sixty-four recently extracted human single rooted premolars were included in the study. The teeth were selected in order to avoid crowns with cracks, cervical lesions, extensive wear, curved roots, resorption, or immature apices Teeth with similar buccolingual and mesiodistal dimensions (7.9 ± .6 mm and 5.2 ± .7 mm respectively) were selected. The teeth were cleaned of soft tissue tags and debris with a hand instrument, followed by an ultrasonic scaler. Teeth were stored in a 1% chloramine solution for 24 hours and in normal saline for the rest of study. Crowns of the teeth were sectioned with a diamond disk (Edenta AG Dentalprodukte, Hauptstrausse, Switzerland) at the most coronal point along the cementoenamel junction (CEJ) perpendicular to the long axis of the root. The roots with rounded cross section of the canal were included in the study. The margins were finished with a chamfer (0.5 mm tall and 0.8 width) using a high speed rounded-end diamond bur (#856-010; D-Z Co, Bern, Switzerland) (Figure 1).

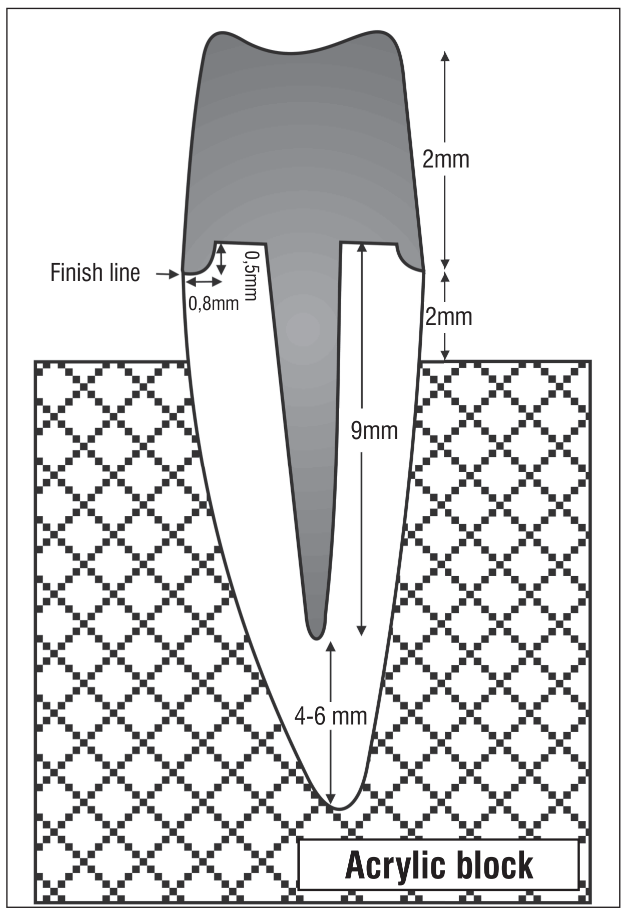

Figure 1 - Schematic illustration of tooth preparation and dimensions of cast post and core
Source: Research data.

The roots were prepared with K files (MANI Inc, Tochigi, Japan) using a step-back technique to a master file size of 40, a working length of 1 mm less than the canal length. Canals were flared up to a size of 80. During instrumentation, a 5.25% hypochlorite solution was used for irrigation. Prepared roots were dried with paper points (GAPA Dent Co, Tianjin City, China) and fitted with a gutta-percha master cone (GAPA Dent Co) that showed "tug-back" at the working length. Each canal was obturated with accessory cones and a eugenol-free sealer (AH26, Lot 0711000699; Dentsply De Trey GmbH, Konstanz Germany) using a lateral condensation technique. Excess material was removed with a heated plugger and sealed with a zinc oxide eugenol-based provisional material (Coltosol, Lot BCL068; Coltene/Whaledent Inc, Apadana Tak, Tehran, Iran). The apical outer third of teeth was also sealed with a glass ionomer cement (Ionofill, Lot 002033; VOCO; 3M ESPE). All teeth were then stored in saline solution for one week. For post fabrication, gutta-percha was removed with #2 reamers (Peeso Reemer; MANI Inc) to create post spaces 9 mm in length, leaving 4-6 mm of gutta-percha apically. Posts were fabricated using passively fitting polycarbonate posts (Pin-jet, Angelus Dental Solution, Londrina, Brazil) adapted to shape of post space and autopolymerizing acrylic resin (Pattern Resin LC, Lot 0505061,GC America Inc, Alsip, Il). Water was used for lubrication. Cores were fabricated by adding acrylic resin to the coronal end of posts to a height of 6 mm which was trimmed to a height of 5.0 ± 0.2 mm. The axial walls were reduced to a total convergence of 10 degrees using a finishing bur (#7004, SSWhite Burs, Inc, Lakewood, NJ) and a high-speed handpiece (Figure 1). The occlusal surface was formed with two cusps with the slope of 15 degrees. A silicone mold (Putty; Speedex, Coltene/Whaledent Inc) was used to standardize the preparations.

The acrylic resin patterns were examined for any voids or defects, which were subsequently corrected with inlay wax (Blue Inlay Casting Wax; Kerr, Romulus, Mich). Resin patterns were vacuum invested with a phosphate-bonded investment (Deguvest CF; Degussa Huls AG, Hanau, Germany), five patterns per casting ring. The patterns were cast in a silver-palladium alloy (Pors-on 4; Degu Dent, Degussa Huls AG, Hanau). Castings were bench cooled, divested, cleaned using air-borne abrasion with 50 µm aluminum oxide (Shenzhen Co, Shanghai, China) under 3 kg/cm^2 of pressure for 15 seconds at a distance of 2 cm, steam cleaned, and adjusted to ensure a passive fit into the root preparations. Defective castings, or castings that required excessive adjustments, were discarded and replacements were made using the previously described procedures. Four categories of luting agents were selected for the study (1). They were chosen because of their different modes of conditioning and adhesion mechanisms. Roots and corresponding castings were assigned to experimental groups (n = 16) based on random numbers generated by a computer software (Excel; Microsoft Canada, Mississauga, Canada). The sample size was measured based on data from a pilot experiment using two-level factorial design for sample size calculation in a statistics software (Minitab v. 14; Minitab Inc, State College, Pa). In group ZP, the canals were cleaned with water and dried with paper points (GAPA Dent Co) and air. Zinc phosphate cement (Harvard Cement, Lot 2111099009; Richter & Hoffmann, Berlin, Germany) was mixed on a cold glass slab according to the manufacturer's instructions. Posts were coated with cement and a lentulo spiral instrument (Dentsply-Maillefer, Ballaigues, Switzerland) was used to deliver cement to the post spaces. The post was then inserted into the canal and held in position with finger pressure until the cement had set. Excess cement was removed after 10 minutes with a sharp explorer.

In group FUJ, canals were cleaned and dried. No additional conditioning was done. A resin-modified glass ionomer cement (Fuji PLUS, Lot 0612121; GC Dental Product Corp, Tokyo, Japan) was mixed according to manufacturer's instruction and applied to post spaces and surfaces. Posts were inserted in their corresponding canals and were held in place with finger pressure. All specimens were light polymerized (Coltolux 50; Coltene/Whaledent, Cuyahoga Falls, Ohio) for 60 seconds, 500mW/cm^2, at a distance of 1.0 mm.

In group VAR, the canals were etched with a 37% phosphoric acid solution (Total etch; Ivolcar Vivadent, Schaan, Liechtenstein) for 15s, rinsed, and dried with paper cones. A dual polymerizing bonding agent (Excite DSC, Lot 0804150; Vivadent) was applied to the post space in 3-4 layers with a disposable tip (Microbrush International, Waterford, Ireland). Excess bonding agent was also removed with paper points (GAPA Dent Co). Equal amounts of base and catalyst pastes of dual polymerizing resin cement (Variolink II, Lot J05817; Ivolcar Vivadent) were mixed and applied to the post and then to the posts space with a lentulo spiral bur (Dentsply-Maillefer). Posts were inserted and retained with finger pressure until initially cured. Excess cement was removed and then the cement was light-cured (Coltolux 50; Coltene/Whaledent) for 60 seconds, with 500 mW/cm^2 irradiance at a 1.0 mm distance.

In group PAN, the root canals were cleaned and dried. A self-etching primer (ED primer, Lot 51169; Kuraray Co. Ltd, Osaka, Japan) was applied to the canal with a disposable tip (Microbrush International) and then air thinned after 60 seconds. The excess of material was also removed from the apical part with paper points. Post surfaces were conditioned with a metal primer (Alloy Primer, Lot 128AC; Kuraray). A dual-cured phosphate methacrylate resin cement (Panavia F, Kuraray,) was then mixed and applied to post surface and not to the post space. The posts were inserted slowly and held in place with finger pressure until cement was initially cured. Excess cement was removed and all margins were covered with an oxygen protecting gel (Oxiguard II; Kuraray). The cement was light cured as in the previous group.

After storage in water for one week, all the specimens were subjected to thermocycling under 5 ˚C and 55 ˚C for 60 seconds each with a dwelling time of 12 seconds. Half of each group was randomly assigned for cyclic loading (CL). Impressions of roots were made using a silicone material (Putty, Speedex; Coltene). The roots surfaces were painted by small amount of a polyether impression material (Impregum F; 3MESPE, Seefeld, Germany) in order to simulate the periodontal ligament. The setting shrinkage of the putty material allowed obtaining a layer 0.3 m thick of polyether material covering the root surface. This ligament-like layer was trimmed to 3 mm apical to the core margin with a scalpel, and mounted in a circular jig using an autopolymerizing acrylic resin (Orthoresin; Dentsply DeTrey, Surry, UK) to embed roots 2 mm apically to the CEJ (Figure 1).

A specially designed apparatus (Taksazan Idea Co., Karaj, Iran) was used to mount the specimens perpendicular to the horizontal plane in the cycling load machine. Loads were applied to occlusal surfaces perpendicular to the long axis of the specimens, with a 1.5 mm diameter loading head (Figure 2). In order to simulate 3 years of service (13), specimens were loaded with 50 N/1.2 HZ for 750,000 cycles in a custom designed machine (Taksazan Idea Co) (Figure 2). Teeth were kept wet during loading with water delivered through small plastic tubes located above the mounted specimens. After completion of the cyclic loading test, the specimens were removed from acrylic blocks. Before the microleakage test, the external surfaces of all teeth were covered with three coats of nail varnish (Revlon, Paris, France). Then specimens were immersed in a 5% fuchsin dye solution (E Merck, Darmstadt, Germany) at room temperature (25 ˚C) for 24 hours. Afterwards, the teeth were thoroughly rinsed under running water and embedded in clear acrylic resin (Orthoresin; Dentsply DeTrey). They were then sectioned into 2 halves longitudinally using a low speed saw (IsoMet; Buehler GmbH,Dusseldorf, Germany).

Microleakage was evaluated at x40 magnification using a stereomicroscope (Zeiss OPM1; Carl Zeiss, Oberkochen, Germany) by one examiner (PM) blinded to cement types and loading conditions. The intra reliability was calculated using weighted kappa (K = .81). Teeth were scored based on the degree of dye penetration as follows (25-30): 0 = no dye penetration, 1 = dye penetration to half of the core-tooth interface, 2 = dye penetration to post, 3 = dye penetration to half of the post length, 4 = dye penetration to the full length of the post. In addition, the lengths of the observed interfaces and the dye penetrations, as well as their ratios were calculated (31, 32).

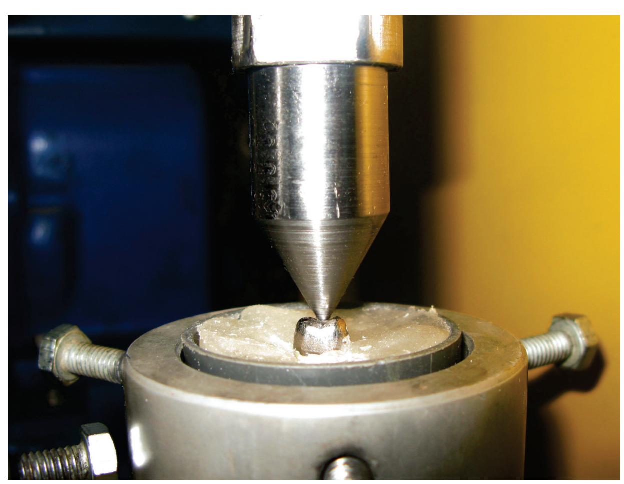

Figure 2 - Schematic illustration of Fatigue loading test
Source: Research data.

Two additional teeth for each of test group were prepared similar to the experimental groups. The access cavity was sealed with a temporary filling material (Coltosol, Coltene/Whaledent). All surfaces of one tooth (negative control) were covered with two layers of nail polisher (Revlon) to ensure the efficiency of nail polisher to prevent the dye penetration. The other tooth was immersed in dye with no nail polisher to serve as positive control. None of control specimens were subjected to fatigue loading.

The mean microleakage scores and proportions of the 4 cements with and without loading were statistically analyzed by nonparametric analyses of variance (Kruskal-Wallis) and multiple comparisons of Dunn to detect significant differences ($\alpha = .05$) with software (SPSS 11, SPSS Inc, Chicago, IL, USA). The Mann-Whitney test was used to analyze the effect of cyclic loading on the microleakage of the test groups ($\alpha = .05$). All data was adjusted by Bonferroni correction.

Results

None of the specimens failed during the loading test. Dislodgements that caused loss of contact with the loading head and fractures were considered as failure. All groups, except the negative controls, showed some degree of microleakage (Table 1). Aside from the positive controls, the greatest microleakage occurred in the ZP group with or without cyclic loading. In positive controls, the dye penetrated along the root canals. In Non-CL group, the least microleakage was observed in the FUJ group (.42 ± .09). When CL was applied, the PAN cement demonstrated the lowest microleakage scores (.79 ± .22).

In Non-CL groups, the Kruskal-Wallis test revealed significant differences in the mean microleakage values among the cements ($p = .007$) (Table 2).

Multiple comparisons revealed that zinc phosphate had significantly higher microleakage values than the other cements ($p < .05$) (Table 3). The other cements did not differ significantly in their microleakage levels. When CL was applied, significant differences were detected among the 4 cements ($p = .006$). Zinc phosphate had a significantly higher microleakage value than the other cements under CL ($p < .05$). However, only zinc phosphate and Fuji PLUS showed significant difference when score data was analyzed. There were no significant differences among the other groups.

The Mann-Whitney test revealed that CL increased the microleakage values in all groups ($p < .05$) (Table 4). However, significant differences were found only for Variolink II cement when score data was analyzed.

Discussion

The results of the present study showed that the cement types used and the presence of cyclic loading influenced cast post and core microleakage. Therefore, both null hypotheses were rejected.

The cements tested in this study are commonly used in daily practice, and were selected based on

Table 1 - Microleakage scores and proportion of microleakage (s.d.) of evaluated groups

Cement	Condition	Proportion		Score				
Harvard	Non-CL**	0.79	(0.02)	0	0	0	1	7
	CL ***	1.00	(0.00)	0	0	0	0	8
Panavia F	Non-CL	0.49	(0.25)	0	1	1	4	2
	CL	0.79	(0.22)	0	0	0	2	6
Fuji Plus	Non-CL	0.42	(0.09)	0	0	0	8	0
	CL	0.73	(0.16)	0	0	0	4	4
Variolink II	Non-CL	0.49	(0.21)	0	1	1	4	2
	CL	0.89	(0.14)	0	0	0	0	8

Note: **Non-CL = without cyclic loading; ***CL = with cyclic loading.
Source: Research data.

Table 2 - Results of Kruskal Wallis analysis

Condition	Data	Chi Square	df	p
Non-CL*	Proportion	12.21	3	.007 (S)
	Score	11.52	3	.009 (S)
CL**	Proportion	12.36	3	.006 (S)
	Score	8.74	3	.033

Note: *Non-CL = without cyclic loading; **CL = with cyclic loading; S = significantly different at α = 0.05.
Source: Research data.

Table 3 - Results (p-values) of multi comparison test. The Bonferroni correction was applied to the data

Cements	Non-CL*		CL**	
	Proportion	Score	Proportion	Score
HAR-PAN	0.028 (S)	0.028 (S)	0.038 (S)	0.442
HAR-FUJ	0.000 (S)	0.002 (S)	0.002 (S)	0.049 (S)
HAR-VAR	0.010 (S)	0.028 (S)	0.038 (S)	1.000
PAN-FUJ	0.574	1.000	0.382	0.442
PAN-VAR	0.959	1.000	0.574	0.442
FUJ-VAR	0.195	1.000	0.083	0.105

Note: *Non-CL = without cyclic loading; **CL = with cyclic loading; S = is significantly different at α = 0.05.
Source: Research data.

Table 4 - Results of Mann-Whitney test on effect of cyclic loading. The Bonferroni correction was applied to the data

Cement	Proportion	Score
Harvard	0.38	0.721
Panavia F	0.028 (S)	0.065
Fuji PLUS	0.000 (S)	0.105
Variolink II	0.001 (S)	0.010 (S)

Note: S = significantly different at α = .05.
Source: Research data.

their polymerization modes and bonding mechanisms. Zinc phosphate cement has been used for almost a century. Its consistently successful clinical performance in fixed prosthodontics is sufficient for it to be considered a gold standard (1, 29). Newer cement classes have been introduced to compensate for the shortcomings of more conventional cements. Resin-modified glass ionomers (RMGIs) have improved physical and mechanical characteristics compared to conventional glass ionomer cements. Combining methacrylate technology with conventional glass ionomer chemistry has increased the strength of RMGIs while lowering their elastic moduli (16). While the bond strength of dentin, resin cement, and the post surface is believed to decrease over time due to hydrolytic degradation, RMGI exhibits more moisture tolerance at the bonded interface (16, 30). Resin cements comprise a wide range of products that share common properties such as high flexural strength, high chemical resistance, and increased retentive capabilities (16, 18, 29). According to several studies, cementation with resin cements increases the retention and fatigue resistance of cast posts and cores (4, 13, 18, 19). Therefore, resin-based cements using bonding systems are recommended for posts and cores cementation in short and/or weakened roots (21), in clinical situations where maximum retention is needed (17), and in teeth with minimal remaining coronal dentin (1).

Zinc phosphate cement showed significantly higher microleakage compared to the other test groups, similar to a previous study (13). Lack of bonding to the tooth structure, solubility in the oral fluid, and inferior mechanical properties have been cited as contributory factors for the weaker performance of zinc phosphate cements (29). No significant differences were detected between Fuji PLUS, Variolink II, and Panavia F. Since no previous study had been performed with these cements, it is difficult to compare this result to others. Direct comparison of the present results with those of other studies investigating the microleakage of different cements with posts is complicated by the variety of materials and/or methodologies that have been used (e.g., different microleakage measuring techniques, lack of thermal cycling, and/or different loading protocols).

Although none of the specimens failed during fatigue loading in the present study, extensive microleakage was seen in all specimens. Only one out of eight specimens in the Panavia F and Variolink II groups obtained a score of 1 (13% and 10%, respectively). When CL was applied, no score less than 3 (46%) was obtained. This finding is consistent with previous studies (23, 24). In a previous evaluation on the fatigue resistance and microleakage of cast posts cemented with Fuji PLUS and of four nonmetallic posts cemented with C&B cement, all the materials exhibited microleakage but no differences in performance (23). In contrast, crack formation and loss of cement adaptation after fatigue loading were seen in another study of post and core systems (24). Microfractures in the cement layer likely serve as the initial site of cement failure and microleakage that are typically undiscovered until catastrophic failure (12, 24). Microfracture subjected to masticatory loads develops into gross tracks, cement disintegration, and post and core failure over time (13, 16, 31). This concept is consistent with the results of the present study, in which all experimental groups showed significantly higher microleakage values upon cyclic loading in a simulated three-year service.

As the quantity of the remaining tooth structure decreases, the role of the post and luting agent becomes more important in the restoration of endodontically treated teeth (1). Therefore, in order to compare directly the amount of leakage with the cement type, the tooth preparation was limited to a chamfer finish line with no coronal dentin wall (ferrule), and crowns were not fabricated for the specimens. However, this preparation design probably had induced larger stresses in the cement layer (31), that caused remarkable microleakage in all specimens making it difficult to identify differences among the adhesive resin cements. This could explain the lack of observed differences in the microleakage of the tested groups and also could have expressed a limitation in extrapolating the results to the clinical scenario. It is suggested that a minimum 1.5-mm ferrule and full coverage restoration can strengthen the remaining tooth structure (1). Clinically, a full coverage restoration with ferrule embracing the root cervically is required whenever a cast post-and-core is used.

One of the limitations of the present study was that the cycling load test design did not allow simultaneously thermal cycling and mechanical loading, contrary to the real situation in oral environment. In addition, finger pressure was used for the cementation of the posts, in accordance to previous studies (4, 5, 10, 13,). Although it might induce lack of standardization to the study, all cementations were performed by only one operator.

Dye penetration and longitudinal sectioning were used to evaluate the microleakage. Despite its limitations, this technique has been the most common method for examining root canal filling (27). Since the depth of dye penetration is not uniform around the post and cores, it is unknown if the section goes through the deepest penetration. Thus, high standard deviations are inherent to this technique (28). In the present study, microleakage was assessed as an ordinal score and proportion of leakage length related to the total length. However, the statistical analysis of these two measurements was sometimes contradictory. This might be attributable to the categorization in score intervals. With this type of scoring some data might be lost and the power of detection of differences might be lower than with the proportion measurement. Even with more sophisticated and reliable microleakage methods, direct extrapolation of the results to the clinical outcomes has to be questioned. More accurate conclusion may be drawn from further studies of endodontically restored teeth that fail clinically.

Conclusion

Within the limitations of the study, it was detected that the adhesive cementation of cast posts and cores with Fuji PLUS, Panavia F, and Variolink II showed significantly less microleakage than those with zinc phosphate cement. Furthermore, fatigue loading increased significantly the microleakage of cast posts with all evaluated materials.

Clinical significance

The use of resin based cements for cast post and core cementation may improve the potential for the clinical survival of endodontically treated teeth.

Acknowledgement

The present research was supported by grant n. 5659 from Vice Chancellor for Research of Tehran University of Medical Sciences. The authors gratefully acknowledge Dr. Pouria Motahari for his assistance in stereomicroscope readings, Dr. Mostafa Fatemi, Dental Materials Department of Dental School, for his help in specimens' preparation, Mr. Fazel Hassan Zadeh for his lab work, and Mr. Fariborz Khashi for his help with fatigue testing.

References

1. Morgano SM, Brackett SE. Foundation restorations in fixed prosthodontics: current knowledge and future needs. J Prosthet Dent. 1999;82(6):643-57.
2. Fokkianga WA, Kreulen CM, Brankhorst EM, Creugers NH. Up to 17-year controlled clinical study on post-and-cores and covering crowns. J Dent. 2007;35(10):778-81.
3. De Backer H, van Maele G, Decock V, van den Berghe L. Long-term survival of complete crowns, fixed dental prostheses, and cantilever fixed dental prostheses with posts and cores on root canal-treated teeth. Int J Prosthodont. 2007;20(3):229-34.
4. Menani LR, Ribeiro RF, de Almeida Antunes RP. Tensile bond strength of cast commercially pure titanium and cast gold-alloy posts and cores cemented with lutting agents. J Prosthet Dent. 2008;99(2):141-7.
5. Usumez A, Cobankara FK, Ozturk N, Eskitascioglu G, Belli S. Microleakage of endodontically treated teeth with different dowel systems. J Prosthet Dent. 2004;92(2):163-9.
6. Habib B, von Fraunhofer JA, Driscoll CF. Comparison of two luting agents used for the retention of cast dowel and cores. J Prosthodont. 2005;14(3):164-9.
7. Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod. 2004;30(5):289-301.
8. Hydecke G, Mathilde CP. The restoration of endodontically treated, single-rooted teeth with cast or direct posts and cores: a systematic review. J Prosthet Dent. 2002;87(4):380-6.
9. Balkenhol M, Wostmann B, Rein Ch, Ferger P. Survival time of cast post and cores: a 10-year retrospective study. J Dent. 2007;35(1):50-8.
10. Mezzomo E, Massa F, Suzuki RM. Fracture resistance of teeth restored with 2 different post-and-core designs fixed with 2 different lutting cements: an in vitro study. part II. Quintessence. 2006;37(6):477-84.
11. Ertugrul HZ, Ismail YH. An in vitro comparison of cast metal dowel retention using various luting agents and tensile loading. J Prosthet Dent. 2005;93(5):446-52.
12. Junge Th, Nicholls JI, Phillip KM, Libman WJ. Load fatigue of compromised teeth: a comparison of 3 luting cements. Int J Prosthodont. 1998;11(6):558-64.
13. Jung SH, Min KS, Chang HS, Park SD, Kwon S, Bae JM. Microleakage and fracture patterns of teeth restored with different posts under dynamic loading. J Prosthet Dent. 2007;98(4):270-6.
14. Mannocci F, Ferrari M, Watson TF. Microleakage of endodontically treated teeth restored with fiber posts and composite cores after cyclic loading: a confocal microscopic study. J Prosthet Dent. 2001;85(3):284-91.
15. Naumann M, Sterzenbach G, Rosentritt M, Beuer F, Frankenberger R. Is adhesive cementation of endodontic posts necessary? J Endod. 2008;34(8):1006-10.
16. Li ZC, White SN. Mechanical properties of dental luting cements. J Prosthet Dent. 1999;81(5):597-609.

17. Torbjorner A, Fransson B. A literature review on the prosthetic treatment of structurally compromised teeth. Int J Prosthodont. 2004;17(3):369-76.

18. Love RM, Putron DG. Retention of posts with resin, glass ionomer and hybrid cements. J Dent. 1998;26(7):599-602.

19. Thongthammachat S, Platt JA, Katona TR, Hovijitra S, Mooe BK. Fracture resistance and fracture resistance after fatigue loading of 4 different post and cores in endodontically treated teeth. Compend Contin Educ Dent. 2006;27(7):396-401.

20. De Munck J, van Lauduty K, Peumans M, Poitvein A, Lambrechts P, Braem M, et al. A critical review of the durability of adhesion to tooth tissue: methods and results. J Dent Res. 2005;84(2):118-32.

21. Nissan J, Dmitry Y, Assif D. The use of reinforced composite resin cement as compensation for reduced post length. J Prosthet Dent. 2001;86(3):304-8.

22. Bolhuis P, de Gee A, Feilzer A. Influence of fatigue loading on four post-and-core systems in maxillary premolars. Quintessence Int. 2004;35(8):657-67.

23. Baldissara P, di Grazia V, Palano A, Ciocca L. Fatigue resistance of restored endodontically treated teeth: a multiparametric analysis. Int J Prosthodont. 2006;19(1):25-7.

24. Freeman MA, Nicholls JI, Kydd WL, Harrington GW. Leakage associated with load fatigue-induced preliminary failure of full crowns placed over three different post and core systems. J Endod. 1998;24(1):26-32.

25. Kelly JR. Clinically relevant approach to failure testing of all-ceramic restoration. J Prosthet Dent. 1999;81(6):652-61.

26. Demirel F, Saygili G, Sahmali S. Microleakage of endodontically treated teeth restored with prefabricated posts and tooth-colored restorative materials. Int J Periodont Rest Dent. 2005;25(1):73-9.

27. Camps J, Pashley D. Reliability of the dye penetration studies. J Endodont. 2003;29(9):592-4.

28. Karagenc B, Gencoglu N, Erosy M, Cansever G, Kulekci G. A comparison of four different microleakage tests for assessment of leakage of root canal filling. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;102(1):110-3.

29. Rosenstiel SF, Land MF, Crispin BJ. Dental luting agents: a review of the current literature. J Prosthet Dent. 1998;80(2):280-301.

30. van Dijken JWV. Resin-modified glass ionomer cement and self-cure resin composite luted ceramic inlays. A 5-year clinical evaluation. Dent Mater. 2003;19(7):670-4.

31. Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH. Microtensile bond strength between adhesive cements and root canal dentin. Dent Mater. 2003;19(3):199-205.

32. Tay FR, Loushine RJ, Lambrechts P, Weller RN, Pashley DH. Geometric factors affecting dentin bonding in root canals: a theoretical modeling approach. J Endod. 2006;31(8):584-8.

Received: 10/15/2010
Recebido: 15/10/2010

Approved: 11/23/2010
Aprovado: 23/11/2010