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Original Article

Effect of Er:YAG laser radiation on pull-out fracture load of esthetic posts luted to root canal dentin with various resin cements

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ABSTRACT

Background: This study investigated the influence of erbium-doped: yttrium aluminum garnet (Er:YAG) laser on the pull-out fracture load of fiber-reinforced composite (FRC) posts luted to dentin with different resin cements.

Materials and Methods: In this *in vitro* experimental study, 90 premolars were endodontically treated. The post spaces were prepared, and the teeth were divided into three groups dependent on the cement applied for luting FRC posts: Group 1: An etch-and-rinse system, Group 2: A self-etch cement, and Group 3: A self-adhesive cement. After 6 months' storage and thermocycling, each group was divided into three subgroups ($n = 10$) according to the treatment applied for removing the posts; subgroup 1: Control, subgroup 2: Treatment with Er:YAG laser at 250 mJ, 20 Hz, and subgroup 3: Treatment by Er:YAG laser at 300 mJ, 10 Hz. The pull-out load was recorded in Newton. The data were analyzed by two-way ANOVA at $P < 0.05$.

Results: The fracture load was significantly affected by the cementation group ($P = 0.005$) and treatment subgroup ($P = 0.008$). The pull-out load of self-etch cement was significantly greater than that of the self-adhesive and etch-and-rinse systems ($P < 0.05$). Treatment with Er:YAG laser caused a significant reduction in pull-out load of FRC posts ($P < 0.05$).

Conclusion: The fracture load of fiber posts is influenced by the type of cement and treatment applied. Post removal would be less challenging when using a self-adhesive or conventional etch-and-rinse cement or using Er:YAG laser at the FRC-resin interface.

Key Words: Lasers, post technique, resin cements, erbium

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INTRODUCTION

Fiber-reinforced composite (FRC) posts have been used since the 1990s to build up the core in endodontically treated teeth with insufficient tooth structure.[1,2] FRC posts provide several advantages over prefabricated and cast metal posts such as more esthetics when applied for anterior teeth, lower risk of vertical root fracture in teeth with narrow root canals, and comparable elastic modulus to dentin.[3,4] The most common type of debonding in FRC posts is the occurrence of fracture at the interface of resin cement and dentin.[2,5] Therefore, several systems have been proposed to promote adhesion of FRC posts to tooth structure. The resinous cements are now considered

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as the standard technique for fixing FRC posts, since they provide high fracture resistance and strong retention to root dentin and reduce microleakage.[4]

Although high bond strength is usually desirable when bonding FRC posts to root canals, occasionally, a post should be removed to allow for a nonsurgical endodontic retreatment to manage a periapical lesion, or to replace a fractured core with another restoration. In these cases, removing the FRC post could be a challenging and time-consuming procedure, which may be associated with fracture and unwanted damage to the root structure. Many techniques and supplementary devices are available for removing post systems, including ultrasonic instruments, diamond burs or piezo reamers, and removal kits developed by the manufacturers of the posts.[6,7] It has been demonstrated that the heat produced by ultrasonic devices during the post removal procedure could generate a large temperature increase and damage periodontal ligaments and alveolar bone.[8]

Different types of resin cements can be employed for bonding FRC posts to root canal dentin. The conventional etch-and-rinse system requires conditioning with 37% orthophosphoric acid followed by the application of a bonding system containing primer and adhesive in the canal prior to luting the esthetic post. The use of three-step etch-and-rinse systems is associated with some difficulty in the clinical setting, as the process is complex and sensitive to environmental factors including water and saliva, which can compromise successful bonding. In self-etch adhesive cements, the etchant and primer have been incorporated and both contribute to the final hybrid layer. The use of self-etch system is associated with lower technique sensitivity and thus facilitating the clinical procedure. However, there are controversies about the adequacy of the hybrid layer and the resulting bond strength of self-etch systems.[9,10] The recently proposed self-adhesive resin cements provide the highest simplicity in the post luting procedure and shorter clinical chair time, as they incorporate the etchant, primer, and adhesive phases of the bonding process in a single clinical step. Although some studies reported comparable bond strength of self-adhesive cements with self-etch and etch-and-rinse systems,[3,11] others demonstrated that infiltration of self-adhesive cements to dental structure is not adequate due to the lower concentration of the acid etchant, and thus lower demineralization and hybridization of dentin.[12,13]

Lasers have been used for various applications in dentistry. Emitted at a wavelength of 2940 nm, erbium-doped: yttrium aluminum garnet (Er:YAG) laser is strongly absorbed by water and is well absorbed by hydroxyapatite, making it a suitable device for removing caries and drilling hard dental tissues.[14-17] The ablation of tooth structure is achieved through a thermomechanical mechanism, involving vaporization of water and organic components.[14] It is believed that erbium family lasers have the potential to ablate dental composite selectively while minimizing inadvertent removal of dental hard tissue.[18-20] We assumed that the ability of Er:YAG laser for removing dental composite combined with the vibration energy occurring during the process of thermomechanical ablation can reduce the bond strength of FRC posts to root canal dentin and thus facilitating the post removal.

According to the authors' knowledge, the effectiveness of Er:YAG laser in reducing the adhesion of fiber posts luted with various resin cements has not been assessed in previous studies. Therefore, this *in vitro* study was conducted to investigate the influence of Er:YAG laser on the pull-out fracture load of FRC posts fixed by three different resin cements. The null hypotheses of this study were as follows: (1) there are no differences in the pull-out fracture load of esthetic posts luted with three types of resin cements (etch-and-rinse, self-etch, and self-adhesive systems) and (2) Er:YAG laser treatment would not affect the pull-out fracture load of fiberglass posts to radicular dentin.

MATERIALS AND METHODS

Sample preparation

The units for this *in vitro* experimental study were ninety freshly extracted human premolar teeth with single straight root canals. The teeth were cleaned and stored in a 0.9% saline solution until the time of the experiment. The selected teeth were free from any fracture or caries and had root lengths of at least 14 mm as measured from the apex to the labial CEJ. The crowns were sectioned with a carborundum disc in a low-speed handpiece at 2 mm above the CEJ. The root canals were then endodontically treated by a single operator using a crown-down technique. The irrigation was performed with a 2.5% sodium hypochlorite solution and the canals were obturated with gutta percha cones and an epoxy-based resin sealer (AH 26; Dentsply Maillefer, Ballaigues, Switzerland). Next, the access cavity was sealed with an eugenol-free temporary filling glass ionomer (Fuji II LC; GC Corp, Tokyo, Japan), and the teeth were stored in a 0.9% saline solution at 37°C for 24 h. The temporary filling material was then removed, and the post space was prepared with Largo Peeso Reamers (#3 and #4; Dentsply Maillefer) at a standard depth of 9 mm. Afterward, the samples were randomly divided into three experimental groups of 30 teeth each. In this experiment, fiber posts (White Post DC #2; FGM, Joinville, SC, Brazil) were employed measuring 1.3 mm in diameter. The posts were cleaned with 96% ethanol before application. The following three types of adhesive resin cements were applied for bonding the posts in the study groups: An etch-and-rinse or total-etch resin cement (Duo-Link; Bisco Inc., Schaumburg, IL, USA), a self-etch resin cement (Panavia F 2.0; Kuraray Medical Inc., Tokyo, Japan), and a self-adhesive resin cement (Clearfil SA Luting; Kuraray Medical Inc., Kurashiki, Okayama, Japan). The composition, and the manufacturers of the materials used in this study are summarized in Table 1. Each cement system was handled according to the manufacturer's instructions, as follows:

For cementation with the etch-and-rinse cement (Duo-Link), the root canal surface was etched with 37% phosphoric acid for 15 s, rinsed with water and dried with absorbent paper points. Then, the Adper Scotchbond Multi-Purpose Plus bonding agent (3M/ESPE, St. Paul, MN, USA) was applied to the root canal surface as the manufacturer's instructions, and the excessive adhesive was removed with absorbent paper points. Afterward, Duo-Link was mixed and inserted into the canal with a syringe and a needle tip. The apical end of the post was also coated with the cement and the post was seated into the canal, quickly.

For cementing the fiber post with the self-etch cement, the ED primer 2.0 of Panavia F 2.0 was applied to the root canal and left undisturbed for 30 s. Next, the mixed Panavia F 2.0 paste was injected into the canal with a syringe and a needle tip. The apical end of the post was coated with the cement and the post was inserted into the root canal, quickly.

For cementation with the self-adhesive cement, the canals were rinsed with water and dried with absorbent paper points. Then, the resin cement was mixed and applied into the canal with a syringe and a needle tip. The cement was also applied to the apical end of the post and the post was quickly inserted into the canal.

In all groups, the post was vibrated during insertion to minimize the inclusion of air bubbles. The posts were seated to full depth and held in position with a static load of about 10 N for 20–30 s. The excess cement was removed by a disposable brush tip. The margin of the post was then light-cured for 40 s at a 45° angle to the edge of the root, using a light-emitting diode (VALO; Ultradent products Inc., South Jordan, UT, USA) at 1400 mW/cm^2. After cementing the post, the coronal parts of the teeth were restored with pink dental composite (PermaFlo; Ultradent products Inc.). This colored composite could be easily removed in the next stages.

Storage condition and surface treatment

After cementation, the root samples were mounted vertically in a metal cylinder (17 mm in diameter and 20 mm in height) using a custom-made aligning device. The inner surface of the metal cylinder was covered with a layer of petroleum and then a cold-curing acrylic resin (Tray Resin II, Shofu, Kyoto, Japan) was poured into the cylinder to embed the root. Afterward, the cylinder was removed, and

Table 1: The commercial name and composition of resin cements used in this study

Resin cement type	Commercial name	Manufacturer	Composition
Etch-and-rinse	Duo-link	Bisco Inc.	Base: Bis-GMA, TEGDMA, urethane dimethacrylate, glass filler, amorphous Silica, ytterbium fluoride Catalyst: Bis-GMA, TEGDMA, glass filler, amorphous Silica
Self-etch	Panavia F 2.0	Kuraray Medical Inc.	Paste A: 10-MDP, silanated silica, hydrophobic aromatic and aliphatic dimethacrylate, hydrophilic dimethacrylate photoinitiator, benzoyl peroxide Paste B: Silanated barium glass, sodium fluoride, sodium aromatic sulfinate , dimethacrylate monomer, BPO
Self-adhesive	Clearfil SA Luting	Kuraray Medical Inc.	Paste A: Bis-GMA, TEGDMA, 10-MDP, hydrophobic aromatic and aliphatic dimethacrylate, silanated barium glass filler, silanated colloidal silica, dl-camphorquinone, benzoyl peroxide, initiators Paste B: Bis-GMA, hydrophobic aromatic dimethacrylate, silanated barium glass filler, silanated colloidal silica, sodium fluoride, accelerators

Bis-GMA: Bisphenol A diglycidyl methacrylate; TEGDMA: Triethylene glycol dimethacrylate; 10-MDP: 10-methacryloyloxydecyl dihydrogen phosphate the resin blocks containing root segments were stored in distilled water at 37°C for 6 months, followed by thermocycling between 5°C and 55°C for 3000 cycles. The coronal composite was then removed with a diamond bur and the 30 specimens in each of the three groups were divided into three subgroups of 10 each, depending on the treatment applied to facilitate post removal, as follows:

Subgroup 1: The specimens in this subgroup were considered as the controls without any treatment.

Subgroup 2: In subgroup 2, an Er:YAG laser (Doctor Smile; Lambda Spa, Brendola, Italy) was irradiated to the interface between the post and resin cement. The beam was emitted at a wavelength of 2.94 µm and was delivered at noncontact, focused mode with fine air and water. The laser handpiece was applied manually for 30 s using short pulse mode and scanning movements throughout the post-cement interface around the post. The choice of pulse energy and pulse repetition rate was 250 mJ and 20 Hz, respectively.

Subgroup 3: In this subgroup, the laser setting and mode of application was similar to that described in subgroup 2, but 300 mJ of energy was applied at the pulse repetition rate of 10 Hz.

The pull-out test

A grip was designed and made to hold the sample in extension. The pull-out test was performed using a universal testing machine (EZ Test, Shimadzu, Kyoto, Japan) with a 200 N load cell. The grip was mounted on the testing machine and the maximum force for extruding the post from the canal was recorded in Newton (N) and considered as the pull-out fracture load. The test was performed parallel to the long axes of the post and tooth at a crosshead speed of 0.5 mm/min.

The fracture mode

Following the pull-out test, the specimens were examined and photographed using a stereomicroscope at ×40 magnification to detect the mode of failure. The fracture mode was classified as follows:

- Adhesive failure: A fracture between the dentin and resin cement or between FRC post and resin cement
- Cohesive failure: A fracture in the FRC post or resin cement or dentin
- Mixed failure: A combination of adhesive and cohesive failures.

Statistical analysis

The normal distribution of the data was confirmed by the Kolmogorov–Smirnov test ($P > 0.05$). Two-way ANOVA was applied to determine the effects of resin cement system, the treatment applied and their interaction, on the pull-out fracture load of FRC posts. Pairwise comparisons were made by *post hoc* least significant difference (LSD) test. The Chi-square test was applied to detect any significant difference in fracture mode among the study groups. The statistical analysis was performed using SPSS software (version 16.0; SPSS Inc., Chicago, IL, USA), and the difference between groups was considered statistically significant at $P < 0.05$.

RESULTS

Table 2 presents the mean and standard deviation (SD) of pull-out fracture load (N) in the study groups and treatment subgroups. The self-etch system exhibited the highest fracture load to root canal dentin (16.3 ± 9.43 N), followed by the etch-and-rinse (11.7 ± 6.3 N) and self-adhesive (10.6 ± 5.93 N) resin cements. Without any treatment, the mean fracture load of FRC posts to root canal dentin was 16.2 ± 10.05 N. The application of Er:YAG laser at 250 mJ/20 Hz and 300 mJ/10 Hz reduced the fracture load to 11.1 ± 6.62 N and 11.3 ± 5.54 N, respectively.

Two-way ANOVA indicated that the type of resin cement ($P = 0.005$) and surface treatment ($P = 0.008$) showed a significant effect on the pull-out fracture load of FRC posts, but the interaction was not significant ($P = 0.156$). *Post hoc* LSD test displayed that

Table 2: The mean±standard deviation of fracture loads (Newton) measured in different resin cement groups and treatment subgroups

Cement	*n*	Control (*n*=10)	Er:YAG laser (250 mJ, 20 Hz) (*n*=10)	Er:YAG laser (300 mJ, 10 Hz) (*n*=10)	Total
Etch-and-rinse	30	13.9±7.12^{Aa}	9.5±6.27^{Ba}	11.6±5.22^{Ba}	11.7±6.30
Self-etch	30	23.2±11.09^{Ab}	13.8±7.99^{Bb}	12.0±4.39^{Bb}	16.3±9.43
Self-adhesive	30	11.6±8.22^{Aa}	10.0±5.12^{Ba}	10.3±4.24^{Ba}	10.6±5.93
Total		16.2±10.05	11.1±6.62	11.3±5.54	

Significant differences at $P<0.05$ were found in the rows marked by different superscript uppercase letters and in the columns marked by different superscript lowercase letters. Er:YAG: Erbium-doped:yttrium-aluminum-garnet the pull-out load of the etch-and-rinse and self-adhesive resin cements were comparable (*P* = 0.560), and both were significantly lower than that of the self-etch cement (*P* = 0.012 for etch-and-rinse and *P* = 0.002 for self-adhesive resin cements). Furthermore, there was no significant difference in the pull-out fracture load between the two laser treatment subgroups (*P* = 0.913), but the fracture load of laser-treated specimens was significantly lower compared to the control subgroup (*P* = 0.006 for 250 mJ/20 Hz and *P* = 0.008 for 300 mJ/10 Hz.).

Analysis of failure modes

The frequencies of failure modes for the different resin cements are presented in Figure 1. Most of the tested specimens showed mixed failure (a combination of adhesive and cohesive failures) and the others showed adhesive failure either between the FRC post and resin cement or between the resin cement and dentin. The statistical analysis revealed no significant difference in the distribution of fracture modes among the study groups (*P* = 0.383).

DISCUSSION

The present investigation sought to find an approach to simplify the removal of intra-radicular posts fixed with different resin cements. The pull-out test was chosen in this study, because testing the post along the entire root canal is more relevant to the clinical reality than using root segments.[21] Although the test was performed over the entire root length, light curing was performed at the cervical third of the post, similar to the clinical conditions. However, the luting cements were dual-cure and allowed to achieve maximum polymerization during the 24 h of storage. The two null hypotheses of the study were rejected as the pull-out fracture load of the fiberglass post was influenced by the type of resin cement and the Er:YAG laser treatment applied at the FRC-cement interface. According to the outcomes of this study, the self-etch cement had significantly higher pull-out fracture load in comparison to etch-and-rinse and self-adhesive resin cements. The lowest fracture load pertained to the FRC specimens luted with the self-adhesive resin cement, although the difference in fracture load between the self-adhesive and etch-and-rinse systems was small and not statistically significant. Exposure to Er:YAG laser affected the efficacy of fiber post removal, since the fracture load of FRC posts to radicular dentin was significantly reduced after laser radiation.

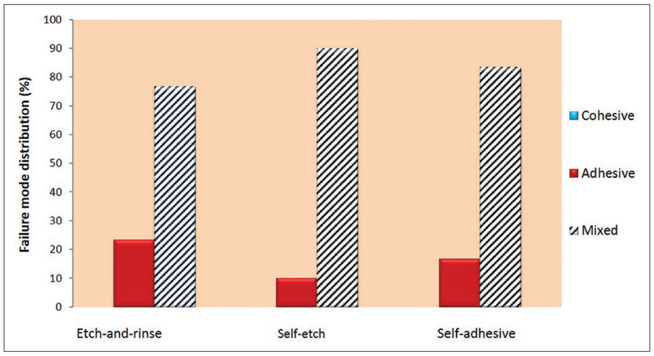

Figure 1: The failure modes found in the experimental groups.

In the etch-and-rinse and self-etch systems, an acidic etchant or a self-etching primer is applied to the root canal dentin to prepare the canal before the cement placement. This allows them to infiltrate the dentin, thus increasing the final adhesive strength. The etch-and-rinse resin cement also contains a bonding system, which is responsible for the adhesion to tooth structure. In the present study, the Scotch bond Multipurpose Plus was used as the bonding system with the etch-and-rinse cement. The mechanism for bonding the etch-and-rinse cement to root canal dentin is micromechanical in nature and functions through the infiltration of resin monomers to demineralized dentin surface to form a hybrid layer.[6] The self-etch resin cement also relies on the formation of a hybrid layer to provide micro-mechanical retention, although the adequacy of the hybrid layer may be lower than that of the etch-and-rinse systems. Furthermore, in self-etch adhesives, some hydroxyapatite is preserved around collagen within the hybrid layer. This residual hydroxyapatite can contribute to additional chemical interaction and consequently to greater adhesive performance.[22,23] In self-adhesive resin cements, the decalcification of root dentin is limited and no evident hybrid layer and/or resin tag formation is observed at the bonded interface.[13] It is assumed that the adhesion of self-adhesive systems to dentin is mainly based on chemical reaction between phosphate methacrylates and calcium ions of hydroxyapatite.[24]

In the present study, the fracture load of FRC posts luted with the self-adhesive resin cement was lowest among the study groups. The etch-and-rinse system also produced a relatively low fracture load that was not statistically different from the self-adhesive cement group. This was somewhat unexpected because previous studies demonstrated that the phosphoric acid used with total-etch systems is more effective than the methacrylated phosphoric esters responsible for substrate conditioning in self-adhesive systems for dissolving the thick smear layer created on the root canal walls during the post space preparation. The comparable bond strength between the self-adhesive and etch-and-rinse cements may be attributed to the greater technique sensitivity of multistep adhesive systems, which nevertheless increases the chance of operator's errors during the adhesion process. It has been shown that incorrect etching, rinsing, drying, primer and bonding application when using the etch-and-rinse systems can adversely affect the performance of adhesive mixture. Another reason may be the long storage time and the exposure to thermocycling process, which has been shown to degrade the bonding effectiveness of most adhesive resin materials.[25-27] It is possible that the aging process used in this study had a more negative effect on the fracture load of etch-and-rinse and self-adhesive cements than that of the self-etch system.

In the present study, the self-etch resin cement showed the highest fracture load among the groups. This was in contrast to the outcomes of previous authors who found that the residual unpolymerized acidic monomers in self-etch resin systems are able to activate the endogenous matrix metalloproteinases (MMPs) present in odontoblasts.[28,29] The activity of MMPs enhances collagenolytic activity and cause degradation of hybrid layer and thus deteriorating the resin-dentin bond over time.[28,29] It should be noted that the self-etch resin cement used in this study (Panavia F. 2) contains 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP), which creates a chemical bond in addition to the micromechanical adhesion to root canal dentin. This chemical bond indicates a low dissolution rate in water and thus reduces hybrid layer degradation and contributes to bond durability.[23,30]

According to the outcomes of this study, it seems that when extra retention is required over a long period of time, the use of a self-etch resin cement containing MDP is more suitable for luting the esthetic posts. If the extra bond strength is not a matter, the self-adhesive resin cement could be considered more applicable in the clinical setting, as it provides adequate adhesion while requiring a simple one-step clinical procedure.

The results of failure type analysis revealed no significant difference in the distribution of fracture modes among the study groups. The predominant type of fracture in all three groups was mixed, with a combination of adhesive and cohesive failures. Previous studies have shown that the weakest link in FRC post adhesion to the canal is the adhesive failure at the interface of resin cement and root dentin.[2,5] No net cohesive failure was observed in any of the study groups according to the failure mode analysis.

The outcomes of this study are in agreement with the results of some previous authors who showed that the retention of FRC posts to dentin was significantly influenced by the type of cementing agent.[31-33] Farina *et al*.[33] indicated that the type of post and cement significantly influenced the push-out bond strength to root canal walls. Calixto *et al*.[31] reported that resin cement system and root region had significant effects on the push-out bond strength of translucent posts, with the self-adhesive resin cement showing lower degree of retention compared to the etch-and-rinse and self-etch adhesive systems. Sadr *et al*.[34] found that the overall clinical performance of the two-step self-etching adhesive system was better than that of the all-in-one adhesive. Koshiro *et al*.[35] found that the bonding interface of the self-etching primer was more stable over time than the wet bonding system.

In contrast to the findings of this study, several studies reported higher bond strength for the self-adhesive resin cement compared to other types of bonding systems.[24,36,37] Zicari *et al*.[36] demonstrated a significantly higher push-out bond strength for the self-adhesive cement compared to an etch-and-rinse and a self-etch luting cement. Bitter *et al*.[24] demonstrated that despite the sporadic observation of a hybrid layer and resin tags, the self-adhesive resin cement had the highest bond strength among the various resin cements used for adhesion of fiber posts, possibly due to the strong chemical interactions between the adhesive cement and hydroxyapatite of root canal dentin. Leme *et al*.[37] found that the bond strength of fiber posts luted with the self-adhesive resin cement was statistically higher than the conventional resin cement at 1-month and 9-month storage times. In a literature review, Radovic *et al*.[38] concluded that the adhesion of self-adhesive cement to dentin and restorative materials seems to be satisfactory and similar to other multistep resin cements. It appears that the conflicting results regarding the bond strength of various luting systems can be explained by the variability in the cement composition, mode of polymerization, storage time, and research methodology.

The outcomes of this study revealed that laser irradiation had a significant effect on the pull-out fracture load of FRC posts attached to root canal dentin. The reduction in pull-out fracture load of FRC posts after exposure to Er:YAG laser could be related to the laser's potential to ablate the adhesive resin cement combined with the vibration energy produced during the process of thermomechanical ablation, which may cause some fractures at the cement interface. Previous studies have shown that Er:YAG laser was efficient for removing composite filling materials and did not cause a temperature increase above the safe limit for the pulp.[18-20,39] Correa-Afonso *et al*.[18] demonstrated that during the ablation of composite resins with erbium family lasers, fast melting leads to changes in the volume of the material and large expansion forces are created, which are followed by explosive vaporization and hydrodynamic ejection. In contrast to the bur, which wears out the restorative material, the laser pulls out the cavity material. This factor may prevent complete removal of cement from the hard dental tissue. It should be noted that the erbium family lasers can also remove enamel, dentin and caries through micro explosive vaporization and hydrodynamic ejection,[14,16,39-43] and thus they should be applied with great care during fiber post removal to prevent unnecessary damage to healthy tooth structure.

The two laser groups in this study differed in some parameters as in one subgroup 250 mJ pulse energy was used at the pulse repetition rate of 20 HZ, whereas in the other subgroup, 300 mJ energy was applied at the pulse repetition rate of 10 Hz. It has been indicated that a higher pulse repetition rate is associated with faster composite removal from the tooth surface at the expense of increasing the risk of inadvertent removal of dental tissues and a higher thermal effect on the pulp during ablation.[18,39] In contrast, the use of low pulse repetition rates during composite removal leads to conservative but less efficient ablation with restorative materials remained attached to hard dental tissues.[18,39] It is believed that energies between 250 mJ and 350 mJ are suitable for ablating restorative materials.[18,43] Although the pulse energy in both laser groups of this study was in the effective zone for ablating filling materials and caused a significant reduction in the fracture load of esthetic posts to radicular dentin, it seems that the use of 300 mJ pulse energy at 10 Hz is more suitable to minimize inadvertent removal of dentin tissue during the process of post removal and prevent from excessive increase in intrapulpal temperature.

Due to the limitations of *in vitro* studies, randomized clinical trials are warranted to generate better evidence on the effectiveness of Er:YAG laser treatment as a tool to facilitate the removal of intra-radicular fiber posts and elucidate the long-term clinical performance of different cements for luting the esthetic posts. Furthermore, it is suggested that future studies evaluate the effectiveness of laser irradiation in combination with other techniques to determine the most optimal strategy for post removal at the shortest possible time, while preserving maximal dental structure.

CONCLUSION

Within the limitations of this laboratory study, the following conclusions can be drawn:

1. The type of resin cement influenced the performance of fiberglass posts along the canal. The self-etching resin cement yielded significantly greater pull-out fracture load than that of the etch-and-rinse or self-adhesive resin cements after 6 months storage in distilled water and exposure to a thermocycling process.
2. Er:YAG laser irradiation was effective in reducing the pull out fracture load of FRC posts bonded to root canal dentin with different resin cements.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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