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ORIGINAL RESEARCH

Ultrasound Effect in the Removal of Intraradicular Posts Cemented with Different Materials

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ABSTRACT

Aim: This study evaluated the effect of ultrasonic vibration on the tensile strength required to remove intraradicular post cemented with different materials.

Materials and methods: Bovine teeth were selected, and 7 mm of the cervical root canals were prepared to size 5 Largo drill, the posts were cemented with zinc phosphate, Enforce (resin) or Rely X (glass ionomer). The specimens were divided into six groups (n = 10), according to the following procedures: GI—cementation with zinc phosphate associated with traction force; GII—cementation with zinc phosphate associated with ultrasonic activation and traction force; GIII—cementation with Enforce associated with traction force; GIV—cementation with Enforce associated with ultrasonic activation and traction force; GV—cementation with Rely X associated with traction force; and GVI—cementation with Rely X associated with ultrasonic activation and traction force. The tensile test was conducted using the electromechanical testing machine, the force was determined by a specialized computer program and ultrasonic activation using the Jet Sonic Four Plus (Gnatus) device in 10P.

Results: Concerning to average ranking, GI showed statistically significant difference in comparison with GII and GVI ($p < 0.05$); there was no statistical difference in GIII and GIV when compared to other groups ($p > 0.05$).

Conclusion: The ultrasound favored the intraradicular post traction regardless of the employed cement in greater or lesser extent.

Clinical significance: The post removal is a routine practice in the dental office, therefore, new solutions and better alternatives are need to the practitioner. We did not find in the literature many articles referring to this practice. Thus, the results from this study are relevant in the case planning and to promote more treatment options.

Keywords: Dental cements, Tensile strength, Ultrasonics.

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INTRODUCTION

Endodontic treatment is often performed on teeth with extreme loss of tooth structure and sometimes intraradicular posts are needed to provide sufficient retention and resistance for the final restoration or crown.[1,2] The persistent microbiota in the root canal can lead to an unsuccessful endodontic treatment and to retreatment indication. The conservative orthograde retreatment is preferred to periradicular surgery.[1] Sometimes the intraradicular post needs to be removed in the conservative retreatment[3] and presents risks of fractures or root perforations, especially with loss dental structure.[1,4] The chosen treatment of the post removal is based in the analysis of different aspects not involving only the intraradicular post,[5,6] but the whole tooth, preserving the integrity of the dental remaining and periodontal ligament.

There are many techniques and devices to facilitate and promote a safer traction of the intraradicular post removal, such as rotary instruments, special forceps, hemostatic tweezers, special devices (Masserann Kit, Eggler post remover, the Ganon post remover, the Ruddle post removal), ultrasonic vibration or a combination of these.[1,7-12]

The instrumentation technique and irrigation solutions interfere in the post retention.[13] Moreover, the type of cement influence the intraradicular retention, since the cement promote higher adhesion to the root walls and keep the post fixed. Currently four types of cementing agents are used to fix posts and to seal the irregularities between the post and the canal walls: zinc phosphate, zinc polycarboxylate, glass ionomer and resin cements.[1,14,15] Glass ionomer and resin cements are largely employed in the intraradicular postcementation due to its adhesive properties. Recently, bioactive materials are also been used in several fields of dentistry.[16] Ceramir, e.g. can be used as a luting agent, working with the same principle of calcium aluminate and glass ionomer cement.[17]

Rely-X is dual-cure glass ionomer cement, self-adhesive and has been compared with different cements.[18-20] Enforce is resin cement presenting dual-setting time that have been studied and evaluated.[21,22] So, when the post-traction is needed, the cement adhesive properties should be considered,[18] since it can lead to more or less difficulty in the post removal.

Thus, the aim of this study was to evaluate the effect of different cements and the association of cementation line wear and ultrasonic vibration applied on the cementation line of different cements during the intraradicular post-traction.

MATERIALS AND METHODS

Sixty extracted bovine teeth were stored in 10% formaldehyde solution for 24 hours and then kept in saline solution until the beginning of the research. The teeth were sectioned at the cervical level, the seven cervical millimeter of each specimen were prepared to size 5 Largo drill. Then, the roots were randomly divided into six groups (n = 10) shown in Table 1.

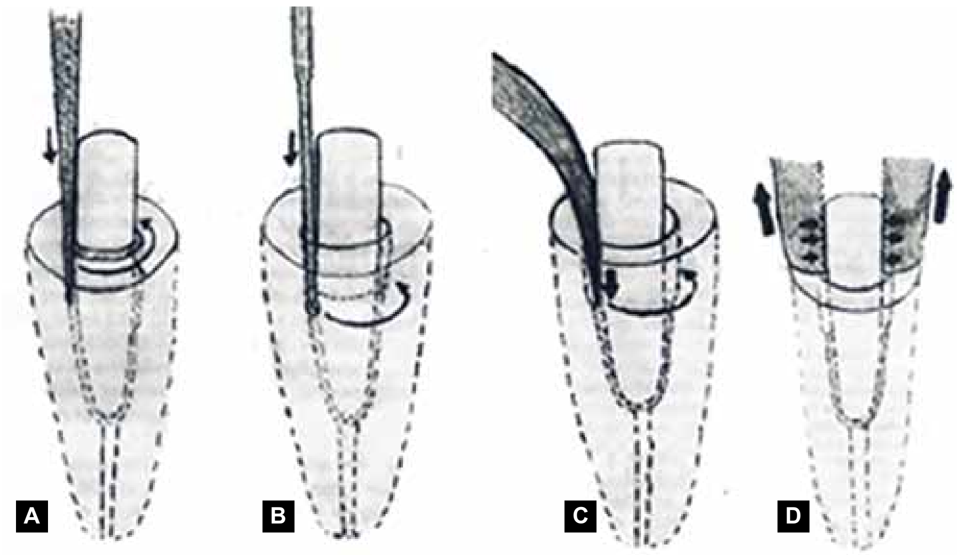
The roots were embedded in polyester resin cylinders (Resina Poliester MIL—ASA, Milflex Indústrias Químicas Ltda., São Bernardo do Campo, SP, Brazil) and submitted to tensile testing using eletromechanical machine (Material Test System—MTS 810). Metallic post had a perforation in its head portion and a 07 orthodontic wire pierced it at the eletromechanical machine.

Table 1: Distribution of groups according to the post removal techniques

Groups	*n*	*Cement*	*Technique*
I	10	Zinc phosphate	Traction
II	10	Zinc phosphate	Wear, ultrasound and traction
III	10	Enforce	Traction
IV	10	Enforce	Wear, ultrasound and traction
V	10	Rely X	Traction
VI	10	Rely X	Wear, ultrasound and traction

Each material was handled according to the manufacturer’s recommendations. During the cement setting time, 5 kg weight was applied to the long axis of the post for 4 minutes. After 15 minutes, the specimens were stored in water and kept at 37°C for 24 hours. Each group was prepared to the tensile testing as the following treatments: GI and GII—zinc phosphate (SSW Artigos Dentários Ltda., Rio de Janeiro, RJ, Brazil) was handled according to the manufacturer’s recommendations, GIII and GIV—enforce with fluoride, resin cement (Dentsply Indústria e Comécio Ltda., Brasil, Petrópolis, RJ, Brazil), was handled according to the manufacturer’s recommendations. Before cementation, the root canal was acid etched for 15 seconds, rinsed with water for 10 seconds, dried using air-spray for 2 seconds and the excess was removed with absorbent paper points. The Prime and Bond 2.1 (Single Bond) adhesive system was applied and light cured for 10 seconds; the cement preparation (paste/paste) was carried out in equal amounts of base and catalyst paste and mixed for 20 seconds. The cement was inserted into the root canal, then the post was placed into the canal and light cured for 30 seconds in the buccal, lingual, mesial and distal faces, and GV and GVI—Rely X, glass ionomer cement (3M) was handled according to the manufacturer’s recommendations. Before cementation, the root canal was etched for 15 seconds, rinsed with water for 10 seconds, dried using air-spray for 2 seconds, and the excess was removed with absorbent paper points. The Prime and Bond ‘2.1 (Single Bond) adhesive system was applied and light cured for 10 seconds. The cement preparation (powder/liquid) was in the 1:1 ratio (3 powder scoops for 3 liquid drops) mixed at the glass plate for 10 seconds. The cement was inserted into the root canal, the post was placed into the canal and light cured for 40 seconds in the oclusal faces.

In GI, the metallic cores were cemented with zinc phosphate and subjected to traction (Fig. 1D), GII, the metallic cores were cemented with zinc phosphate and submitted to wear in the cementation line about 1 mm depth around the post using a nº 2200 diamond bur (KG Sorensen Ind Com Ltda., Barueri, SP, Brazil) at high speed handpiece (Fig. 1A), and 3 mm depth using ‘long neck’ bur (Maillefer, Ballaigues, Switzerland) at low speed



Figs 1A to D: Sequence of the cast metallic core removal and the cementation line wear using the 'pencil tip' diamond bur (a) deep wear using the LN bur (b) ultrasonic application in the cementation line (c) and the traction (d)

(Fig. 1B). Then, the specimens were subjected to ultrasonic vibration (Jet Sonic Four Plus, Gnatus), in periodontics 10P, using the periodontics tip number 2 within the gap created in the cementation line wear, for 120 seconds (30 seconds in the buccal, mesial, lingual and distal faces) under copious irrigation with distilled water (Fig. 1C). The specimens were submitted to traction (Fig. 1D), in GIII, the metallic cores were cemented with Rely X glass ionomer and subject to traction (Fig. 1D), in GIV, the metallic cores were cemented with Rely X glass ionomer and subject to wear in the cementation line about 1 mm depth around the post using a n° 2200 diamond bur (KG Sorensen Ind Com Ltda., Barueri, SP, Brazil) at high speed handpiece (Fig. 1A), and 3 mm depth using 'Long Neck' bur (Maillefer, Ballaigues, Switzerland) at low speed (Fig. 1B). Then, the specimens were subjected to ultrasonic vibration (Jet Sonic Four Plus, Gnatus), in periodontics 10P, using the periodontics tip number 2 within the gap created in the cementation line wear, for 120 seconds (30 seconds in the buccal, mesial, lingual and distal faces) under copious irrigation with distilled water (Fig. 1C). The specimens were submitted to traction (Fig. 1D), in GV, the metallic cores were cemented with Enforce resin cement and subjected to traction (Fig. 1D), in GVI, the metallic cores were cemented with Enforce resin cement and submitted to wear around the cementation line about 1 mm depth using a n° 2200 diamond bur (KG Sorensen Ind Com Ltda., Barueri, SP, Brazil) at high speed handpiece (Fig. 1A), and 3 mm depth using 'long neck' bur (Maillefer, Ballaigues, Switzerland) at low speed (Fig. 1B). Then, the specimens were submitted to ultrasonic vibration (Jet Sonic Four Plus, Gnatus), in periodontics 10P, using the periodontics tip number 2 within the gap, that was created in the cementation line wear, for 120 seconds (30 seconds in the buccal, mesial, lingual and distal faces) under copious irrigation with distilled water (Fig. 1C). The specimens were submitted to traction (Fig. 1D).

The specimens were submitted to tensile strength test using the electromechanical testing machine (Material Test System—MTS 810). The force required to traction force similar to the clinical situation (Fig. 1D) and data were analyzed using the Test Works program for Test Star II system. The load cell used was 1 kN and the speed was 1 mm/minute. The results among experimental groups are shown two by two using Newman-Keuls test with 5% significance level.

RESULTS

The ultrasound application time (with no traction associated) and the tensile strength required for the post removal determined the ranking for each specimen, the rank sum was calculated for each group and the data were submitted to statistical tests.

The ordering of the experimental groups from most to least efficient in the intraradicular post removal according to the average ranking is shown in Table 2.

Concerning to average ranking, GI showed statistically significant difference in comparison with GII and GVI ($p < 0.05$); there was no statistical difference in GIII and GIV when compared to other groups ($p > 0.05$).

DISCUSSION

Dentin posts are mechanically inserted into the prepared cavity to support and maintain the final restoration. Attin et al compared the fracture resistance of glued restorations *vs* those using posts and they observed

Table 2: Experimental groups ordered from most to least efficient in the intraradicular removal according to the average ranking

Groups	Efficiency order (tensile strength)	Rank sum	Average ranking
GI	5 (128.01)	407	40.7[a,d]
GII	2 (69.92)	220	22.0[b]
GIII	4 (103.48)	315	31.5[a,b,d]
GIV	3 (91.28)	269	26.9[a,b,c]
GV	6 (139.54)	429	42.9[a,d]
GVI	1 (60.69)	190	19.0[b,c]

[a,b,c,d]Different letters indicate statistically significant difference on the same column ($p < 0.05$).

that the fracture resistance was higher when the posts were employed.[23] This is a practical and conservative resolution for large restorations. Thus, the use of posts presents a usually practice that promotes more lasting success of the final restoration.

In the cases of intraradicular post removal, the dental structure condition must be considered especially when an endodontic treatment was performed due to the remaining structure is more fragile and susceptible to fracture. Moreover, there is a consensus that worn teeth can be a result from a combination of long-lasting etiological factors, which increases the teeth wear over de the years.[24,25] Thus, a correct diagnosis and treatment planning should be carefully planned to avoid further dental damage.

Recently, Marques et al examined the influence of the instrumentation technique and irrigating solutions on the bond strength of the glass fiber posts to radicular dentin. The specimens were submitted to tensile test at a constant speed of 1.0 mm/minute and load 2,000 Kgf comparing manual and rotary instrumentation and irrigation with 2.5% hypochlorite and 2% chlorhexidine. The authors concluded that irrigation with 2.5% hypochlorite presented a negative effect on the posts mechanical retention in both instrumentations.[13] Thus, the difficulty in the posts removal can be associated to several factors and is facilitated using effective devices.

Among the types of posts, the cast metallic core,[7] prefabricated,[1] direct bond retention[26] or glass fiber post[13] are available options to the treatment. The cast metallic post was chosen due to it is more suitable to the bovine tooth dimensions after a standardized preparation of root canals as described above.

The intraradicular post removal using ultrasound promoted greater safety and preservation of the remaining dental structure during this procedure. Berbert et al had proven the effectiveness of ultrasonic vibration even when magnetostrictive devices (Profi-Endo) were used. The application for 2 minutes decreased about 30% of the required force for the displacement of prosthetic core cemented with zinc phosphate cement.[14] On the other hand,[27] analyzed whether metal type, cement type and the use of ultrasonic vibration influence the amount of tensile force required to remove parallel-sided, prefabricated, metal posts from tooth roots. In this *in vitro* experiment, metal type, cement type and ultrasonic vibration did not influence the force required to remove posts.

Berbert et al evaluated the effect of ultrasonic application in the intraradicular post removal on the head portion of intraradicular post and in the cementation line, both situations were associated to cementation line wear around the post, and the standard depth was 3 millimeters.[7] Situations, such as the ultrasonic application on the head portion of the post, with no cementation line wear or only the cementation line wear were also evaluated. All these situations preceded the core traction, the tensile strength required to the post displacement was quantified, and the control group was only subjected to traction with no prior preparation. The authors concluded that the cementation line wear associated with ultrasound application in the cementation line before the traction was significantly more effective than only traction, the cementation line wear, the ultrasound application on the post head portion and cementation line wear associated with ultrasound application in the cementation line of the post head portion techniques before the traction.

The present study evaluated the ultrasonic application on different cementing agents according to the protocol recommended by Berbert et al.[7] The results showed that all cements were affected by the ultrasonic application before the traction and the required tensile strength for the intraradicular post removal was significant statistically decreased, except for Rely X that presented no significant statistical result.

All experimental groups that were not subjected to ultrasonic application presented similar mean strength required for the intraradicular post displacement, regardless the kind of cement. The groups that were subjected the ultrasonic application also presented similar average ratios of tensile strength.

CONCLUSION

This study concludes that all cements were affected by ultrasonic application and had the traction of the intraradicular post facilitated. Further studies should be conducted to supplement these data and improve this procedure.

CLINICAL SIGNIFICANCE

The post removal is a routine practice in the dental office, therefore, new solutions and better alternatives are need to the practitioner. We did not find in the literature many recent articles referring to this procedure. Thus, the results from this study are relevant in the case planning and to promote more treatment options.

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