

Efficacy of ultrasound in removal of intraradicular posts using different techniques

Neilor Mateus Antunes Braga, Edson Alfredo, Luis Pascoal Vansan, Tabajara Sabbag Fonseca, José Antonio Brufato Ferraz and Manoel Damião Sousa-Neto

School of Dentistry, University of Ribeirão Preto, UNAERP, Ribeirão Preto, SP, Brazil

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Abstract: The efficacy of ultrasound in removing cast metal posts was evaluated in this *in vitro* study using one or two ultrasound units and ultrasonic vibration for various lengths of time. The crowns of 30 healthy maxillary canines were removed, the roots were embedded in acrylic resin blocks, and the root canals were treated endodontically. The canals were prepared and their impressions were taken with self-curing acrylic resin. After casting with copper-aluminum alloy, the posts were blasted with aluminum oxide and cemented with Panavia F resin cement. The specimens were divided into five groups. In groups I and II, only one ultrasound unit was used for 30 and 60 s, respectively; in groups III and IV, two ultrasound units were used simultaneously for 30 and 60 s, respectively; in group V, ultrasound was not used (control). Ultrasonic vibrations were applied with an Enac OE-5 ultrasound unit and an ST-09 tip. All samples were subjected to traction on an Instron machine (model 4444) at a cross-head speed of 1 mm/min. Analysis of the results revealed a statistically significant difference between the groups (ANOVA, $P < 0.01$); however the difference between groups II and IV was not statistically significant. The efficacy of ultrasound in removing intraradicular posts was confirmed, and the most effective technique was the use of two ultrasound units, independent of the length of time ultrasound was applied. (J. Oral Sci. 47, 117-121, 2005)

Keywords: intraradicular post; cast metal post; traction resistance; post removal; ultrasound; endodontics.

Introduction

It is necessary to remove intraradicular posts when their length or diameter is inadequate and compromises their retention, or when the apical seal of the obturation is imperfect. Either of these two factors may result in treatment failure (1).

Intraradicular posts are usually used in weakened teeth with little remaining coronal structure. Therefore, post removal requires special care and techniques to prevent root fracture or perforation. A number of techniques and instruments have been recommended for post removal, such as a post extractor (2,3), a post puller (4), a Gonon post-pulling system (5,6), the Masserann technique (7), hemostats (8) and burs to drill the post. These methods and procedures, although effective in removing intraradicular posts, may occasionally fracture the root, remove too much dental structure, or perforate the root.

Several authors (9-12) have suggested the use of ultrasound alone or in combination with other techniques to make this procedure safer. Ultrasound is a mechanical form of energy: high-intensity ultrasonic vibrations are generated in the ultrasound unit and transferred to the metal post to break the cement layer between the post and the canal wall. According to Berbert et al. (13), removal of the post is easy once the cement is broken. Garrido et al. (14) have demonstrated the efficacy of ultrasonic vibrations for removing posts. They also showed that cooling affects ultrasound efficacy depending on the type of cement used to lute the metal posts. They reported that, when the posts had been fixed with resin cement, the use of ultrasound with irrigation did not reduce the force

Correspondence to Dr Manoel D. Sousa-Neto, St Célia de Oliveira Meireles 350, Jd Canadá, 14024-070 Ribeirão Preto, SP, Brazil

Tel: +55-16-623-6002

Fax: +55-16-603-6783

E-mail: sousanet@unaerp.br

required for removal.

The objective of this *in vitro* study was to evaluate the efficacy of ultrasound in removing cast metal posts when one or two ultrasound units were used for different lengths of time.

Materials and Methods

Thirty human maxillary canines were selected from the University of Ribeirão Preto Dental Research Laboratory according to morphology and the size of their roots: straight single canal and root, with no unusual morphology.

The teeth were sectioned transversally at the cemento-enamel junction with a carbide disc under air-water cooling to standardize the length of the roots to 13 mm; their crowns were discarded. The roots were centralized vertically in aluminum cylinders and fixed with self-curing resin up to 1 mm from the edge of their cervical portion.

All roots were endodontically treated. The working length was established at 12 mm, which was 1 mm from the apex. The root canals were prepared using the crown-down technique, and the apical foramen was enlarged to fit a # 50 Kerr file (Dentsply-Maillefer, Ballaigues, Switzerland). The canal was irrigated with 1% sodium hypochlorite during instrumentation. After instrumentation, the canals were irrigated with 10 ml distilled water, aspirated with metal suction tips, and dried with paper points.

All canals were obturated with laterally condensed gutta-percha cones (Dentsply-Herpo, Petrópolis, Brazil) and Sealer 26 cement, which contains calcium hydroxide and bismuth oxide agglutinated with bisphenol-epoxy-based resin (Dentsply-Brasil, Petrópolis, Brazil). Excess cement was removed with a heated Paiva plugger. The pulp chamber was cleaned and the root canal opening was sealed with Coltosol temporary cement (Vigodent, Rio de Janeiro, Brazil). After root canal obturation, the specimens were stored at 37°C for 72 h. The temporary cement was subsequently removed. Heated condensers were used to remove up to 5 mm of the obturation.

Post spaces (8 mm long) were prepared with a # 6 Largo bur (1.7 mm in diameter) in a low-speed handpiece attached to a parallelometer to ensure that the preparations were parallel to the long axis of the roots and to maintain a standardized diameter. After preparation, the canals were irrigated with distilled water and dried with paper points. Root canal impressions were taken with Duralay self-cured acrylic resin (Reliance Dental Mfg, Worth, IL, USA) and Pinjet prefabricated polycarbonate posts (Angelus Odontológica, Londrina, PR, Brazil). A ring was attached to the core to facilitate attachment to the Instron 4444 Universal testing machine (Instron Corporation, Canton,

MA, USA) for the tension test.

After casting in copper-aluminum alloy (Goldent L.A., Comercial Importação e Exportação., São Paulo, Brazil) and aluminum oxide blasting, the cast post and core were adjusted to the root canals. The post was 8 mm long, the core was 5 mm, and the ring to be attached to the Instron machine for the tension test was approximately 8 mm in diameter.

All posts were cemented with Panavia F resin cement (Kuraray, Osaka, Japan) according to the manufacturer's instructions. First, the root canals were irrigated with distilled water and dried with paper points and air. Equal amounts of ED primer from flasks A and B were mixed for five seconds and applied to the dentine with a Microbrush point (Dentsply, Rio de Janeiro, Brazil). After 60 seconds, a mild air jet was applied. Equal amounts of base and catalyst pastes were mixed for 30 seconds with a plastic spatula.

The cement was introduced into the post space using a spiral lentulo; the posts were coated with cement, inserted into the post space, and kept under constant finger pressure for 60 s. Excess cement was removed from the edges with a disposable brush. Each surface of the core (buccal, lingual and proximal) was light-cured for 30 s at the cementation line for a total of 2 min. After light-curing, Oxyguard II gel was applied at the cementation line for 10 min and then removed with cotton swabs. Finally, the whole set was washed with air-water spray.

All specimens were stored in distilled water at 37°C for 72 h, after which they were randomly divided into 5 groups of 6 specimens each: group I - ultrasonic vibration with one unit for 30 s on each surface (buccal, mesial, lingual, distal); group II - ultrasonic vibration with one unit for 60 s on each surface; group III - ultrasonic vibration with two units, for 30 s on two opposed surfaces at the same time (buccal and lingual for 30 s, and mesial and distal for 30 s more); group IV - the same sequence as group III, but for 60 s; group V - no ultrasonic vibration (control).

Ultrasound was applied with Enac OE-5 ultrasound units (Osada Electric, Tokyo, Japan) and ST-09 tips (Osada) perpendicularly to the long axis of the metal post.

All specimens underwent tension tests with an Instron 4444 Universal testing machine. Each specimen was attached to the machine and an increasing tension force was applied to the post at a cross-head speed of 1 mm/min until the post was dislodged from the root canal. The results of tension tests were recorded in megapascal (MPa) and analyzed statistically with ANOVA and the Tukey test.

In the present study, the traction force (F) was related to the post cementation area (A) in order to obtain the tensile

strength values (σ , Table 1), by means of the equation: $\sigma = F / A$, where:

- σ = tensile strength, in Pa (Pascal);
- F = traction force, in N (Newton);
- A = cementation surface area, in m² (square meters).

The cementation area is equal to the lateral area (LA) added to the base area (BA), since the upper area of the post was not cemented (Fig. 3). Since the post diameter was 1.7 mm, the height was 8 mm and the post was cone-shaped, the final equation was: $\sigma = F / 45$ (in MPa).

Results

Table 1 and Fig. 1 show the tensile stress values (MPa) necessary to dislodge the intraradicular posts during the tension test using the Instron 4444 Universal testing machine.

Data were subjected to Bartlett’s test in order to verify the variances of the samples. The results showed no differences between variances ($P = 0.6047$), which allowed use of the ANOVA test.

Statistical analysis of the original tension test values using ANOVA showed a significant difference ($P < 0.01$) between the groups, and Tukey’s post-test showed that groups I, II and V (one ultrasound unit used for 30 s and for 60 s, and no ultrasound) were significantly different from each other and also from groups III and IV. The results for groups III and IV (two ultrasound units for 30 s and for 60 s) were statistically similar (Table 1).

Discussion

There have been many previous reports describing techniques and instruments to facilitate the removal of intraradicular posts. Despite the large number of techniques available, priority has been given to those that carry a

lower risk of root fracture and perforation, involve less drilling of the remaining dental structure, and that can be used for both anterior and posterior teeth.

To overcome the difficulties involved in the removal of metal intraradicular posts and to make this procedure safer, ultrasonic vibration has been suggested as an

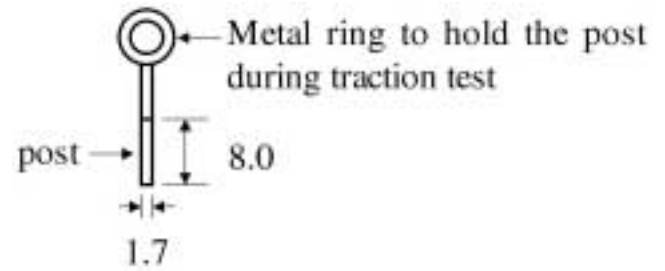


Fig. 3 Schematic drawing of the radicular post (dimensions in millimeters).

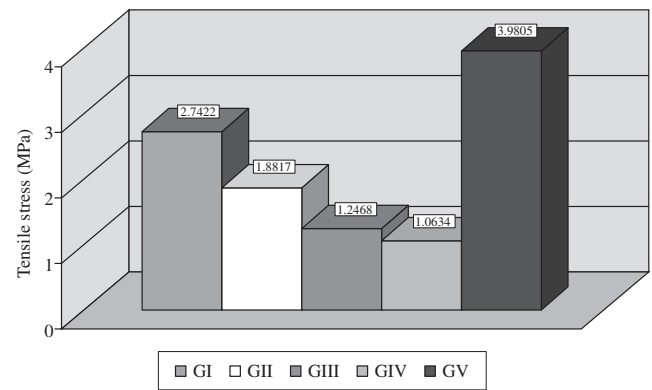


Fig. 1 Mean tensile stress values (MPa) for each group.

Table 1 Tensile stress values (MegaPascal) necessary to dislodge intraradicular posts according to the number of ultrasound units used and the time ultrasonic vibration was applied to each tooth surface

	1 ultrasound unit		2 ultrasound units		None Group V
	Group I 30 s	Group II 60 s	Group III 30 s	Group IV 60 s	
	2.2691	1.6313	1.0379	0.6956	3.6827
	2.4514	2.4736	1.3646	1.0245	4.3672
	2.6114	1.7002	1.0756	1.7513	3.8916
	2.9448	2.0402	1.2468	0.7245	3.9538
	3.1581	1.7291	1.0112	1.5779	3.8316
	3.0181	1.7157	1.7446	0.6067	4.1561
Mean ± SD	2.7425a	1.8824b	1.2468c	1.0623c	3.9805d
	± 0.3509	± 0.3231	± 0.2793	± 0.4895	± 0.2448

Means followed by different letters are statistically different (Tukey test). Tukey critical value = 0.73135.

alternative technique for removal, either alone or in combination with other techniques (9-12,14).

The development of improved procedures for currently used techniques is as important as the development of new techniques. The purpose of this study was to evaluate whether the simultaneous use of 1 or 2 ultrasound units for variable amounts of time could reduce the force necessary to remove intraradicular posts.

Comparison of results for the ultrasound groups with those of the group without ultrasound confirmed that ultrasonic vibration reduces the force necessary to remove cast metal posts cemented with Panavia F resin cement independent of the number of units or the time used. These results are in agreement with those reported by Gaffney et al. (9) and Berbert et al. (13). According to Berbert et al. (13), the use of ultrasound for 2 and 5 min reduces the force necessary to remove cast metal posts cemented with zinc phosphate by 30-35% when compared to removal of the same type of intraradicular posts without ultrasound. Garrido et al. (14), however, used resin cement in a similar trial and did not find any statistically significant difference between the group for which ultrasound and irrigation were used and the group for which ultrasound was not used.

Our results revealed that the use of two ultrasound units at the same time is more efficient than the use of only one unit, independent of the length of time. This may be explained by the fact that ultrasound vibrations emitted simultaneously by the two units overlap and produce a physical effect known as constructive interference, which is the sum of the power that each unit would produce individually (Fig. 2). This effect produced greater weakening of the adhesion of the cement to the dentinal walls and to the metal post, and consequently, a lower force was sufficient for removing the posts.

Our results also showed that an increase in ultrasonic vibration time from 30 to 60 s decreased the force required to remove the posts when only one unit was used (2.7422 Mpa vs 1.8817 MPa). However, when two units were used

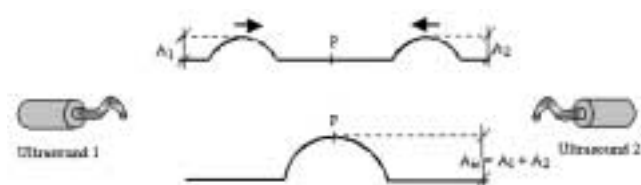


Fig. 2 Schematic design of the constructive interference of the ultrasound vibrations produced by 2 units (A_1 - amplitude of ultrasound 1 vibration; A_2 - amplitude of ultrasound 2 vibration; A_{ic} - resulting amplitude of the constructive interference; P - point of interface of post with cement).

simultaneously and the time was varied from 30 to 60 s, the decrease in force was not statistically significant.

The increase in ultrasonic vibration time with one unit resulted in greater weakening of the cement interface and a consequent reduction in the value of the force required to remove the posts, in agreement with findings reported by Dixon et al. (11). The same was not found for the simultaneous use of 2 ultrasound units, which may be explained by the fact that the increase in ultrasonic vibration time from 30 to 60 s when using two units (1.2468 MPa vs 1.0634 MPa) might not have been enough to produce statistically significant differences between the forces necessary to dislodge the post. Future studies should investigate the effect of longer ultrasonic vibration times than those used in this study.

Conclusions

We conclude that (1) the use of ultrasound is effective for removing intraradicular posts and reduces the force necessary for removal; (2) an increase of ultrasonic vibration time results in a reduction of the force necessary to remove the post; (3) the simultaneous use of two units is more efficient than the use of only one unit.

References

1. Hülsmann M (1993) Methods for removing metal obstructions from the root canals. *Endod Dent Traumatol* 9, 223-237
2. Neaverth EJ Jr, Kahn H (1968) Re-treatment of dowel-obtured root canals. *J Am Dent Assoc.* 76, 325-328
3. Warren SR, Gutmann JL (1979) Simplified method for removing intraradicular posts. *J Prosthet Dent* 42, 353-356
4. Bando E, Kawashima T, Tiu IT, Kubo Y, Nakano M (1985) Removing dowels in difficult teeth. *J Prosthet Dent* 54, 34-36
5. Machtou P, Sarfati P, Cohen AG (1989) Post removal prior to retreatment. *J Endod* 15, 552-554
6. Sakkal S, Gauthier G, Milot P, Lemian L (1994) A clinical appraisal of the Gonon post-pulling system. *J Can Dent Assoc* 60, 537-539
7. Williams VD, Bjorndal AM (1983) The Masserann technique for the removal of fractured posts in endodontically treated teeth. *J Prosthet Dent* 49, 46-48
8. Stamos DE, Gutmann JL (1993) Survey of endodontic retreatment methods used to remove intraradicular posts. *J Endod* 19, 366-369
9. Gaffney JL, Lehman JW, Miles MJ (1981) Expanded use of the ultrasonic scaler. *J Endod* 7, 228-229

10. Chalfin H, Weseley P, Solomon C (1990) Removal of restorative posts for the purpose of nonsurgical endodontic retreatment: report of cases. *J Am Dent Assoc* 120, 169-172
11. Dixon EB, Kaczkowski PJ, Nicholls JI, Harrington GW (2002) Comparison of two ultrasonic instruments for post removal. *J Endod* 28, 111-115
12. Alfredo E, Garrido ADB, Souza-Filho CB, Corrêa-Sobrinho L, Sousa-Neto MD (2004) In vitro evaluation of the effect of core diameter for removing radicular post with ultrasound. *J Oral Rehabil* 31, 590-594
13. Berbert A, Filho MT, Ueno AH, Bramante CM, Ishikiriama A (1995) The influence of ultrasound in removing intraradicular posts. *Int Endod J* 28, 100-102
14. Garrido ADB, Fonseca TS, Alfredo E, Silva-Sousa YTC, Sousa-Neto MD (2004) Influence of ultrasound, with and without water spray cooling, on removal of posts cemented with resin or zinc phosphate cements. *J Endod* 30, 173-176