WJD

10.5005/jp-journals-10015-1277

ORIGINAL RESEARCH

Comparison of Different Ultrasonic Tip Angulations on Time Required for Cast Post Removal

[1]Eduardo Galera da Silva, [2]Ana Claudia Carvalho Xavier, [3]Maria Beatriz Beber Kamozaki
[4]Ana Paula Martins Gomes, [5]Carlos Rocha Gomes Torres, [6]Clóvis Pagani

ABSTRACT

Aim: The aim of this study was to design, develop and compare ultrasound tips with different angulations on time required for cast post removal.

Materials and methods: To test and compare the ultrasonic tips developed, 36 metal patterns were fabricated from tin bars, on a mechanical precision lathe. Each metal pattern simulated an endodontically treated tooth, without coronal remaining, prepared to receive a cast post with 10 mm long. The cast posts were cemented with zinc phosphate cement. The metal patterns with their respective intraradicular posts cemented were stored at 37ºC, at relative humidity 100%, for a period of 48 hours. After this period, the specimens were randomly divided into three groups, and each group was submitted to the action of one of the ultrasonic tips (n = 12): G1—tip with 30º angulation; G2—tip with 45º angulation and G3—tip without angulation (straight tip). Each ultrasonic tip was used on the surfaces of the cast posts (mesial, distal, buccal, lingual and incisal) for 5 seconds, at maximum power, until the cast post removal using an ultrasound device (Jet Sonic, Satelec System, Gnatus, Ribeirão Preto, SP, Brazil). The time required for cast posts removal was recorded and the data statistically analyzed by the ANOVA and Tukey tests ($p < 0.05$).

Results: The means of time evaluated for cast posts removal were G1: 59.25s; G2: 119.0s and G3: 48.4s. Group 2 presented the highest mean value in seconds, differing statistically from G1 and G3. No significant differences were observed between G1 and G3.

Conclusion: It may be concluded that the ultrasonic tip angulation had a direct influence on the time required for cast posts removal by ultrasound. When the different ultrasonic tips were compared, the 30° angulation and the straight tips required a shorter ultrasonic vibration time. All cast posts luted with zinc phosphate were successfully removed in a relatively short time by the different ultrasonic tips analyzed.

[1]Assistant Professor, [2,3]Postgraduate Student
[4,5]Associate Professor, [6]Titular Professor

[1]Department of Social and Pediatric Dentistry, São José dos Campos Institute of Science and Technology, UNESP, São Paulo State University, São José dos Campos, São Paulo, Brazil

[2-6]Department of Restorative Dentistry, São José dos Campos Institute of Science and Technology, UNESP, São Paulo State University, São José dos Campos, São Paulo, Brazil

Corresponding Author: Ana Claudia Carvalho Xavier, Rua Pedro Ernesto, n° 240, apto 254 – Jardim São Dimas, São José dos Campos, São Paulo, Brazil, CEP: 12.245-520, Phone: +55 (12) 3922-3791, e-mail: anaccx@gmail.com

Keywords: Dental materials, Post and core technique, Zinc phosphate cement, Ultrasonics.

How to cite this article: da Silva EG, Xavier ACC, Kamozaki MBB, Gomes APM, Torres CRG, Pagani C. Comparison of Different Ultrasonic Tip Angulations on Time Required for Cast Post Removal. World J Dent 2014;5(3):147-151.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Endodontically treated teeth might exhibit inferior strength and may be more brittle than vital teeth owing to destruction and loss of dental tissues, presence of caries, improper root canal instrumentation and restorative procedures.[1-4] Consequently, these teeth are at a higher risk of experiencing fracture.[5] The fracture potential of root canal filled teeth has been studied extensively, however, no definite causal relationship between fracture and the type of restoration has been established, and controversies remain about which materials or techniques are best for their restoration.[6]

In many situations, the remaining coronal tooth structure of endodontically treated teeth is insufficient to anchor coronal restorations.[5] Therefore, endodontically treated teeth often require post-and-core restorations for retention purposes because of extensive structural defects resulting from caries and access cavity preparation.[7-8]

Cast posts have good resistance and adaptation to root canals, resulting in a uniform thickness of cement.[9] However, post removal can be necessary, when the length or diameter of the post is unsatisfactory, or when the apical seal of the root filling is inadequate, requiring a nonsurgical reintervention.[10,11] Many techniques and instruments are advocated for post removal, such as the use of burs or trephines, devices that grasp the posts so that they can be pulled out of the root, and the use of ultrasound alone or in combination with other techniques.[11-18]

Ultrasonic energy is transmitted to the post, causing cracks in the cement, thus facilitating post removal.[11,16] This technique presents suitable efficiency and safety, while preserving the root integrity.[19] Several factors may interfere in the ultrasonic efficiency, such as the type of luting agent, length, form, diameter and type of post and post adaptation to the root canal walls.[8,17,18,20,21] The efficacy of ultrasound is related to the intensity and movement of the vibration, the manner in which the tip is applied on the core and the type of tip used.[11,21] With respect to the type and angulations of tips, few studies have investigated the effect of different type of tips for intraradicular post removal with the use of ultrasonic vibration, especially with regard to tip angulation. Thus, it is interesting to conduct researches about new ultrasonic tips that may facilitate cast posts removal. Therefore, the aim of this study was to design, develop and compare ultrasound tips with different angulations on time required for cast post removal. The null hypothesis tested was that the different ultrasonic tips angulations do not influence the time required to remove cast posts cemented with zinc phosphate cement.

MATERIALS AND METHODS

In order to conduct this study, a new methodology was proposed, in which no human or bovine teeth were used. A mechanical precision lathe was used to machine 36 metal patterns from tin bars. Each metal pattern simulated an endodontically treated tooth without coronal remaining, prepared to receive a cast post. Thus, a single machined metal piece was obtained, measuring 20 mm high and 15 mm in diameter. A conical perforation was made in the center of the pattern, simulating a root canal with 6° of taper degree and length of 10 mm, so that the cervical diameter was 2 mm and the apical diameter was 1.1 mm. A small concavity with a radius of 1 mm was made on the flat smooth surface of the metal pattern, at its surface angle, to prevent the possibility of the cast post rotating, facilitate modeling and orient its position at the time of cementation.

To determine the number of test specimens, a statistical view of the experiment was necessary, in which 12 specimens were defined as the ideal number of cast posts for each ultrasound tips studied, totaling 36 metal patterns with their respective cast posts. The 36 metal patterns were numbered, and by the modeling process, 36 replicas of the cast posts were fabricated of chemically activated acrylic resin (Duralay, Reliance Dental, Worth, IL, USA). With the 36 replicas made of resin, the inclusions and castings were made. Posts were cast using a copper-aluminum alloy (Goldent LA, São Paulo, SP, Brazil). After adjustment of post to metal pattern, the post surface was sandblasted with aluminum oxide particles. All posts were cemented in the metal patterns using a phosphate zinc cement (SS White Dental Products, Rio de Janeiro, RJ, Brazil) mixed following the manufacturer's instructions. The cement was placed on the post surface and into the post-hole using a lentulo spiral, followed by insertion of the post. After the post was in position, a 5 kg force was applied to the incisal surface, following the long axis of the posts for 10 minutes.

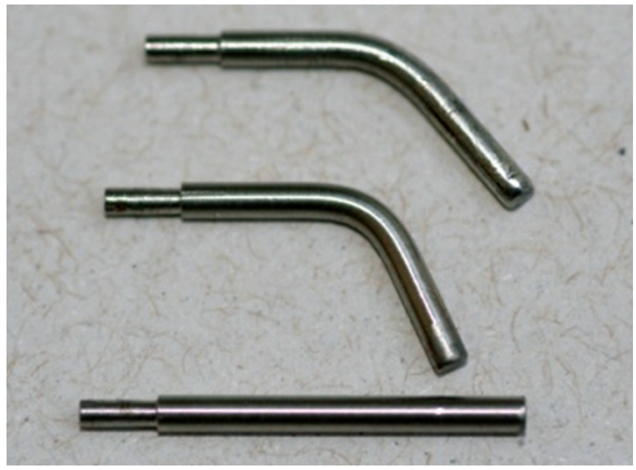


Fig. 1: Ultrasonic tips with 30° angulation, 45° angulation and straight tip (without angulation)

The specimens were stored at 37ºC and 100% humidity for 48 hours before ultrasound vibration and were randomly divided into three groups (n = 12) according to type of tip angulation: G1—tip with 30º angulation, G2—tip with 45º angulation and G3—tip without angulation (straight) (Fig. 1). The ultrasonic tips were made from a flat bar of molybdenum in straight form, and were fabricated by CVD, Dentus (São José dos Campos, São Paulo, Brazil), according to the following measurements: 16 mm long and 1.5 mm in the active part.

Ultrasound Application

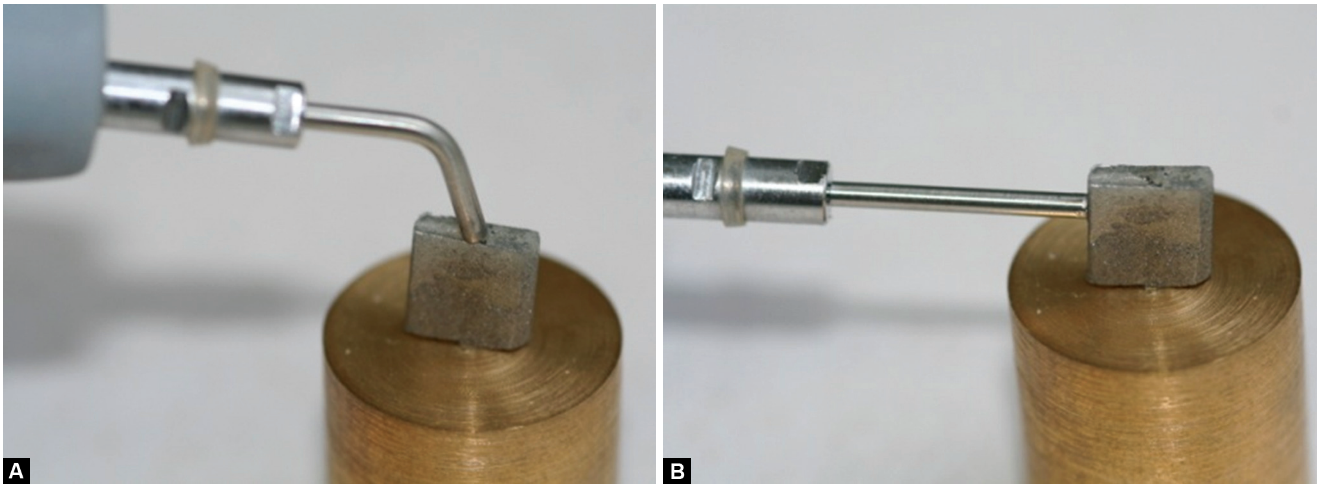
After the specimens had been stored for 48 hours, an ultrasonic device (Jet Sonic, Satelec System, Gnatus, Ribeirão Preto, SP, Brazil) was used for cast posts removal, at maximum power (30 KHz) under water cooling by a single operator. The vibration was applied successively to the buccal, mesial, lingual, distal and incisal of the cast posts surfaces for 5 seconds, controlled with a timer (Figs 2A and B). The time required to completely dislodge each cast post was recorded with a digital chronometer (Tecnbrás Indústria e Comércio Ltda, São Paulo, SP, Brazil). The values obtained were analyzed by ANOVA and Tukey's test ($p < 0.05$).

RESULTS

Table 1 shows the mean time necessary to dislodge the cast posts during ultrasonic vibration. All the cast posts were removed. In G2, the time required for cast post removal was longer, differing statistically from G1 and G3. There was no statistically significant difference between G1 and G3.

DISCUSSION

When conventional retreatment is performed in a tooth with an existing post or core, this must be removed prior to



Figs 2A and B: Ultrasound tips application on the surfaces of cast posts cemented in the metal patterns

treatment. In many cases, posts can be easily removed, while in some situations this is not so simple.[22] The difficulty in the posts removal is related to various factors, such as length, shape, diameter, type of post and cement used,[23] in addition to the operator's skill and technique used.[24,25] Cylindrical, long and broad posts generate greater stress in the root canals and are more difficult to remove when compared with tapered, short and thin posts.[5]

The present study compared the effect of variations in the tip angulations on the application of ultrasonic vibration for cast post removal. Thus, an improved performance of the ultrasonic effect was observed when the 30° angulation tip and straight tip were used (Table 1). The results showed that the ultrasonic tip angulation had a direct influence on the time required for cast post removal. Thus, the null hypothesis was rejected.

During the planning stage of this research, it was endeavored to reduce the number of variables in the methodology. Therefore, no human or bovine teeth were used, and a new metal appliance with strict standardization was developed to implement the methodology. The metal patterns and the respective cast posts were fabricated to minimize the variations inherent to dentin and to the root canal anatomy. By standardization of the substrate, it was sought to evaluate the direct effect of the tips and ultrasound vibration on the cast posts and cementation agent. Although *in vitro* tests are not always able to reproduce *in vivo* conditions, they can offer comparative values that may guide clinical procedures.[18]

Table 1: Mean time (in seconds) and standard deviation required for cast post removal

Groups (n = 12)	*Mean time (in seconds)*	*Standard deviation*	*Statistical analysis**
G1	59.25	2.24	A
G2	119	2.13	B
G3	48.42	2.32	A

*Different letters indicate statistically different results (Tukey test, $p < 0.05$)

When an ultrasonic device is used for post removal, the vibration is transferred to the cement line by the post. Thus, the vibration is expected to cause the cement to fracture and facilitate the post removal procedure.[11] In the present study, the different ultrasonic tips were successively applied for 5 seconds on the buccal, mesial, lingual, distal and incisal surfaces of cores. This alternative vibration increases the fragmentation of the zinc phosphate cement, thus favoring the detachment of the intraradicular posts.[17,21] The power and the frequency of the ultrasonic waves generated by the device determine the physical characteristics of the vibrations.[11] Ultrasound efficiency depends on the equipment. Equipment used at present has two means of ultrasonic wave generation: a reverse piezoelectric effect that transforms electric energy into mechanical energy. During this conversion, there is no loss of energy in the form of heat and thus ultrasound frequency maintains constant or magnetic inertia effect that converts magnetic energy into mechanical energy. During this conversion, there is a loss of energy in the form of heat and there is frequency oscillation.[26] Piezoelectric ultrasound equipment was used in this study, because it is considered more efficient for post removal.[22]

Considering the time necessary to dislodge intraradicular posts, some studies have shown that posts cemented with zinc phosphate required a rather short period of time (up to 3 minutes) to be dislodged.[26] The results of the present study showed that all the cast posts were successfully removed in a short time interval (mean time up to 2 minutes). Variations from 2 to 16 minutes[15,16,18,27,28] in vibration time necessary to dislodge the posts can be attributed to experimental design differences.[17]

In the present study, an effort was made to maximize the energy transfer from the instrument tip to the post, evaluating the angle and the position of the tip in relation to the post, according other authors.[17] The end tip of the ultrasound was positioned on the incisal and lateral surfaces of the post, for a period of 5 seconds in each side. The cement layer opposite to the ultrasound is destroyed before the one from the same side on which it had been placed.[28] The ultrasonic vibration induced fracture propagation in the cement itself, and also separation of cement from the mettalic cast. These findings suggesting that the resistance to ultrasonic vibration is smaller in the metal-cement interface than in the dentin-cement interface. The resistance to ultrasonic vibration seems to be influenced by the surface conditions of the substratum and the type of luting material.[17] Several studies have reported that the type of luting agent can have an influence on the ultrasonic efficiency for post removal.[8,16,18] Zinc phosphate cement was used in this study, because it is the main material used to lute cast posts and cores with a satisfactory performance.[11,29]

In this study, all the cast posts were removed in short periods of time. These results suggest that the smaller the angle of the ultrasonic tip used, the shorter will be the vibration time required to remove the cast posts. These results may be attributed to the direct propagation of ultrasonic vibration on the surface of the cast posts. The angle of application of this vibration and the ultrasound tip angulation had influence on the time required for dislodgment of the cast posts. Considering that the cast posts are used in anterior and posterior teeth, the association of ultrasonic tips with different angulations may be considered an interesting, fast and safe option for the cast posts removal.

CONCLUSION

Within the limitations of this *in vitro* study, it may be concluded that the ultrasonic tip angulation had a direct influence on the time required for cast posts removal by ultrasound. When the different ultrasonic tips were compared, the 30^{o} angulation and the straight tips required a shorter ultrasonic vibration time. All cast posts luted with zinc phosphate were successfully removed in a relatively short time by the different ultrasonic tips analyzed.

REFERENCES

1. Schwartz R, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod 2004; 30(5):289-301.
2. Vârlan C, Dimitriu B, Vârlan V, Bodnar D, Suciu I. Current opinions concerning the restoration of endodontically treated teeth: basic principles. J Med Life 2009;2(2):165-172.
3. Santana FR, Castro CG, Simamoto-Júnior PC, Soares PV, Quagliatto PS, Estrela C, Soares CJ. Influence of post system and remaining coronal tooth tissue on biomechanical behaviour of root filled molar teeth. Int Endod J 2011;44(5):386-394.
4. Soares CJ, Valdivia ADCM, Silva GR, Santana FR, Menezes MS. Longitudinal clinical evaluation of post systems: a literature review. Braz Dent J 2012;23(2):135-140.
5. Al-Omiri MK, Rayyan MR, Abu-Hammad O. Stress analysis of endodontically treated teeth restored with post-retained crowns: a finite element analysis study. J Am Dent Assoc 2011;142(3): 289-300.
6. Rodrigues FB, Paranhos MP, Spohr AM, Oshima HM, Carlini B, Burnett LH Jr. Fracture resistance or root filled molar teeth restored with glass fiber bundles. Int Endod J 2010;43(5):356-362.
7. Heydecke G, Peters MC. The restoration of endodontically treated, single-rooted teeth with cast or direct posts and cores: a systematic review. J Prosthet Dent 2002;87(4):380-386.
8. Soares JA, Brito-Júnior M, Fonseca DR, Melo AF, Santos SMC, Sotomayor NDCS, Braga NMA, Faria e Silva AL. Influence of luting agents on time required for cast post removal by ultrasound: an in vitro study. J Appl Oral Sci 2009;17(3):145-149.
9. Cheung W. A review of the management of endodontically treated teeth: post, core and final restoration. J Am Dent Assoc 2005; 136(5):611-619.
10. Ruddle CJ. Nonsurgical retreatment. J Endod 2004;30(12):827-845.
11. Braga NMA, Silva JM, Carvalho-Júnior JRC, Ferreira RC, Saquy PC, Brito-Júnior M. Comparison of different ultrasonic vibration modes for post removal. Braz Dent J 2012;23(1):49-53.
12. Shemen BB, Cardash HS. A technique for removing cemented posts. J Prosthet Dent 1985;54(2):200-201.
13. Cheuk SL, Karam PE. Removal of parallel prefabricated posts: a clinical report. J Prosthet Dent 1988;59(5):531-533.
14. Stamos DE, Gutmann JL. Survey of endodontic retreatment methods used to remove intraradicular posts. J Endod 1993; 19(7):366-369.
15. Berbert A, Filho MT, Ueno AH, Bramante CM, Ishikiriama A. The influence of ultrasound in removing intraradicular posts. Int Endod J 1995;28(2):100-102.
16. Gomes APM, Kubo CH, Santos RAB, Santos DR, Padilha RQ. The influence of ultrasound on the retention of cast posts cemented with different agents. Int Endod J 2001;34(2):93-99.
17. Silva MR, Biffi JCG, Mota AS, Fernandes Neto AJ, Neves FD. Evaluation of intracanal post removal using ultrasound. Braz Dent J 2004;15(2):119-126.
18. Brito-Júnior M, Soares JA, Santos SMC, Camilo CC, Moreira Júnior G. Comparison of the time required for removal of intraradicular cast posts using two Brazilian ultrasound devices. Braz Oral Res 2009;23(1):17-22.
19. Castrisos T, Abbott PV. A survey of methods used for post removal in specialist endodontic practice. Int Endod J 2002;35(2):172-180.
20. Braga NMA, Alfredo E, Vansan IP, Fonseca TS, Ferraz JAB, Sousa-Neto MD. Efficacy of ultrasound in removal of intraradicular posts using different techniques. J Appl Oral Sci 2005; 47(3):117-121.
21. Garrido ADB, Osorio JED, Silva-Sousa YTC, Sousa-Neto MD. Evaluation of several protocols for the application of ultrasound during the removal of cast intraradicular posts cemented with zinc phosphate cement. Int Endod J 2009;42(7):609-613.
22. Alfredo E, Garrido ADB, Souza-Filho CB, Correr-Sobrinho L, Sousa-Neto MD. In vitro evaluation of the effect of core diameter for removing radicular post with ultrasound. J Oral Rehabilitation 2004;31(6):590-594.

23. Standlee JP, Caputo AA, Hanson EC. Retention of endodontic dowels: effects of cement, dowel length, diameter and design. J Prosthetic Dent 1978;39(4):400.
24. Bando E, Kawashima T, Tiu IT, Kubo Y, Nakano M. Removing dowels in difficult teeth. J Prosthet Dent 1985;54(1):34-36.
25. Matchou P, Sarfati P, Cohen AG. Post removal prior to retreatment. J Endod 1989;15(11):552-554.
26. Dixon EB, Kaczkowski PJ, Nicholls JL, Harrington GW. Comparison of two ultrasonic instruments for post removal. J Endod 2000;28(2):111-115.
27. Johnson WT, Leary JM, Boyer DB. Effect of vibration on post removal in extracted human premolar teeth. J Endod 1996; 22(9):487-488.
28. Yoshida T, Gomyo S, Itoh T, Shibata T, Sekine I. An experimental study of the removal of cemented dowel-retained cast cores by ultrasonic vibration. J Endod 1997;23(4):239-241.
29. 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):164-169.