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

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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 37°C, 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 30° angulation; G2—tip with 45° 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 cement. The metal patterns with their respective intraradicular posts cemented were stored at 37°C, 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 30° angulation; G2—tip with 45° 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).

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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 cement were successfully removed in a relatively short time by the different ultrasonic tips analyzed.

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

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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. Consequently, these teeth are at a higher risk of experiencing fracture. 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.

In many situations, the remaining coronal tooth structure of endodontically treated teeth is insufficient to anchor coronal restorations. 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.

Cast posts have good resistance and adaptation to root canals, resulting in a uniform thickness of cement. 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. 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.

Ultrasonic energy is transmitted to the post, causing cracks in the cement, thus facilitating post removal. This technique presents suitable efficiency and safety, while preserving the root integrity. 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. 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.\textsuperscript{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.

The specimens were stored at 37°C 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 30° angulation, G2—tip with 45° 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 (Tecnbras 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
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In many cases, posts can be easily removed, while in some situations this is not so simple. The difficulty in the posts removal is related to various factors, such as length, shape, diameter, type of post and cement used, in addition to the operator’s skill and technique used. 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.

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.

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. 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.

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

<table>
<thead>
<tr>
<th>Groups (n = 12)</th>
<th>Mean time (in seconds)</th>
<th>Standard deviation</th>
<th>Statistical analysis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>59.25</td>
<td>2.24</td>
<td>A</td>
</tr>
<tr>
<td>G2</td>
<td>119</td>
<td>2.13</td>
<td>B</td>
</tr>
<tr>
<td>G3</td>
<td>48.42</td>
<td>2.32</td>
<td>A</td>
</tr>
</tbody>
</table>

*Different letters indicate statistically different results (Tukey test, p < 0.05)
according other authors. 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. The ultrasonic vibration induced fracture propagation in the cement itself, and also separation of cement from the metallic 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. Several studies have reported that the type of luting agent can have an influence on the ultrasonic efficiency for post removal. 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.

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° 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


