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Comparative Analysis of Ultrasonic Apparatus for Removing Cast Post and Cores

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Abstract

This study evaluated the effectiveness of different ultrasound machines for removing metal cast post-and-cores. 24 models of maxillary central incisors roots were made using acrylic resin. Each root had his canal patterned with resin Duralay (Reliance Dental) for making prosthetic metal cast post-and-cores, which were fused in Nickel-Chromium alloy (VeraBond II). Cores were cemented to the roots using zinc phosphate cement (*SS White*) and then stored in a humid environment for 30 days. The samples were divided randomly into two groups (n = 12), according to the ultrasound equipment used to remove the cores. For group I, a Sonic Jet-Total (Gnatus) unit was used and for Group II the Jet Ultrasound (D700) appliance was used. For removal of cores, both devices were operated at full power, with ultrasonic tips focusing on each face of the cores by up to 60 seconds, starting by the buccal surface and at the sequence, palatal, mesial, distal and incisal surfaces until the core have been removed or the cycle completed. The time required for removing each of the cores was tabulated, and the obtained data were statistically analyzed by student's t-test for independent samples. No statistical difference was observed between the analyzed groups (p> 0.005). It can be concluded that both devices tested showed the same level of effectiveness in the removal of intracanal cores.

Keywords: Ultrasonic vibration; Post and core technic; Device removal

Introduction

The maintenance of endodontically treated teeth and with great losses of coronary structure requires the use of post-and-core to perform the prosthetic rehabilitation treatment. Due to their physical properties, metal post-and-cores are widely used, and present a high level of success because they present as a conservative and effective solution, conditioned to adequate periodontal support [1-3]. Some clinical situations, such as insufficient physical and mechanical strength on the post-and-core, concentrated stresses in the coronal third of endodontically treated and rehabilitated teeth, failure of endodontic treatment or even the need for prosthetic replacement, lead to the indication of atraumatic and efficient removal of them for the accomplishment of the treatment indicated for each case [1,4]. Because of the risk of weakening, perforating or fracture of the root structure several criteria related to the post-and-core and to the dental element must be taken into account in order to evaluate the feasibility of the removal procedure [5-9]. Different techniques and devices for this purpose have been proposed in the literature, among them the following stand out: simple traction performed by means of manual instruments; with the use of devices suitable for this purpose, such as the "little giant" proposed by Warren & Gutmann[10] and Bando et al. [11], the "gonon" used by Machteu et al. [12], the "masseran kit" by Willians & Bjorndal [13]; wear with drills at high or low speed, and more recently, the use of ultrasound combined with mechanical traction [14,15]. The choice of the removal technique should be the most adequate and safe, which preserves the integrity of the dental remnant and the support periodonto the maximum. Ultrasound devices were introduced in dentistry for periodontal treatment and only in 1980 had their use extended to endodontic therapy and removal of intra-radicular post-and-core [16]. Through the transmission of sonic vibrations to the intra-radicular retainers, the ultrasound is able to break the cement line interposed between the post and the walls of the root canal. Thus, manual mechanical traction is favored by the need to apply a smaller amount of force to remove the pin, besides saving time, minimal loss of dental structure, less risk of accidents such as perforations or root fractures and ease of application in any region of the oral cavity[17-20].

Because of the wide variety of ultrasound devices available on the market, the aim of this study

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Figure 1: Root included in plaster.

Figure 2: Cemented cast metal post-and-core.

Figure 3: Standardization of the pressure exerted during the cementation.

Figure 4: Jet Sonic apparatus - Total (Gnatus).

Figure 5: Jet Ultrasound Device (D700).

Figure 6: Application of ultrasonic energy to the nucleus.

was to compare different ultrasound marks in the time required to remove molten metal cores. The null hypothesis tested was that there is no difference in the time of removal of the nuclei between the devices tested.

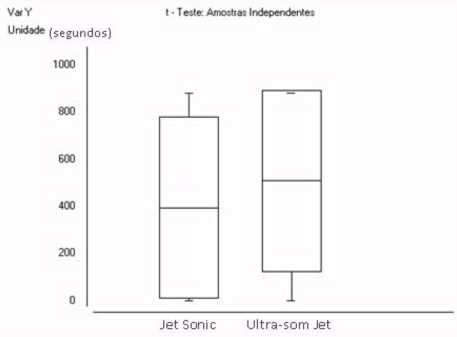
Materials and Methods

Twenty four roots of upper central incisors were made of acrylic resin from the same matrix, with a length of 13 mm. After the preparation, the roots were included and fixed in common plaster, exposing the coronary portion at cervical level (Figure 1). After inclusion, the roots were prepared according to the following description: the intra-root preparations were performed using diamond drill bit 4138 (KG Sorensen), fixed to the high-speed (Kavo) pen with constant cooling. The intra-radicular spaces were then modeled in Duralay resin (Reliance Dental) for the preparation of prosthetic cores, which were cast in a Nickel-Chromium prosthesis laboratory alloy (VeraBond II). The metallic nuclei presented the intra-radicular portion measuring 10 mm in length and the extra-radicular portion measuring 4 mm in height. After casting, the cores were subjected to sandblasting with aluminum oxide, to increase the mechanical bonding between the metallic post-and-core and the cement layer used in the fixation. The nuclei were fixed to the intra-radicular preparation with Zinc Phosphate (SS White) cement, handled according to the manufacturer's specifications and inserted into the preparations with the aid of a straight exploratory probe. To standardize the pressure exerted on the cementation of the cores, a weight of 1.4 kilograms was used, which for 5 min, timed by a digital timer, will remain supported on the cores. After cement prepping, the excess was removed with exploratory probe, and the samples were placed inside plastic containers, creating a humid environment for 30 days (Figure 2 and 3). Samples were randomly divided into 2 groups of 12 specimens each, according to the ultrasound apparatus used. For group 1 samples, the Jet Sonic -Total ultrasound device (Gnatus-Figure 4) was used, and in group 2, the Jet Ultrasound device (D700-Figure 5) was used. Both devices evaluated were used at their maximum power, according to the manufacturers' instructions for removal of crowns/cores. The incidence of the tips, always under constant jet of water, occurred on each of the faces of the nuclei, for periods of up to 60 seconds in each of them, measured by a digital timer from the moment of the activation and contact of the ultrasound with the face of the nucleus (Figure 6), beginning by vestibular face and in the sequence, palatal, mesial, distal and incisal faces, until the nucleus was removed or, if the cycle was completed without removal, it was repeated for a maximum of three times. Removal of the core was considered when it was detached from the root structure and not when it only rotated inside the root. The time required to remove each of the cores was tabulated in Microsoft Excel (Microsoft) software to be analyzed by Student's t-test, at a significance level of 5%.

Table 1: Mean (± standard deviation) of the time, in seconds, spent on removal of nuclei for each ultrasound apparatus tested (Student's t-test, p> 0.05).

	Jet Sonic	Ultrassom Jet
Média	394.16*	509.16*
DP	(±385,17)	(±394,84)

*Equal letters mean absence of statistical difference (p> 0.05).



Graph 1: Boxplot showing the results obtained.

Results and Discussion

The results obtained are described in Table 1 and are shown in Graph 1. No statistically significant difference (p = 0.472) was observed in the time of removal of molten metal cores between the ultrasound marks tested. Endodontically treated teeth need post-and-cores to promote prosthetic or restorative rehabilitation. Although currently prefabricated pins are widely used, the molten metal cores have a high level of success [4]. However, it is sometimes necessary to remove these and ultrasound has been widely used for this purpose. Berbert et al. [7] (2002) confirmed that this is a safer technique and favors the preservation of the remaining dental structure. Different techniques can be associated with the ultrasonic device for pin removal, according to Glick & Frank [21] (1986). Techniques included: application of the ultrasonic tips directly on the structures to be removed; opening a small space between the pin and the dental structure for insertion of a tip or file that transmits the ultrasonic vibration; and the use of braided files around the silver cone, with the aid of a solvent (chloroform) favored the dislodgement from the interior of the canal. Several factors may affect the efficiency of ultrasonic vibration during post removal, including the length, form, diameter and type of post, cement type used and post adaptation to the root canal walls. Thus, Ultrasound is sound energy with a frequency above the range of human hearing, which is 20 kHz. The range of frequencies employed in the original ultrasonic units was between 25 kHz and 40 kHz. Subsequently the so-called low-frequency ultrasonic handpieces operating from 1 kHz to 8 kHz were developed, which produce lower shear stresses, thus causing less alteration to the tooth surface. There are two basic methods of producing ultrasound. The first is magnetostriction, which converts electromagnetic energy into mechanical energy. A stack of magnetostrictive metal strips in a handpiece is subjected to a standing and alternating magnetic field, as a result of which vibrations are produced. The second method is based on the piezoelectric principle, in which a crystal is used that changes dimension when an electrical charge is applied. Deformation of this crystal is converted into mechanical oscillation without producing heat. Piezoelectric units have some advantages compared with earlier magnetostrictive units because they offer more cycles per second, 40 versus 24 kHz. The tips of these units work in a linear, back-and-forth, "piston-like" motion, which is ideal for endodontics. As a result the file vibration displacement amplitude does not increase linearly with increasing generator power. This applies in particular when "troughing" for hidden canals or when removing posts and separated instruments. Additionaly, Other authors also point out that a cavitation effect, due to the local agitation of the irrigating solution, could also aid in the fragmentation of the remaining cement line subjected to ultrasonic vibration [22]. The analysis of the time required for detachment and removal of molten metal core is also studied. In the present work two ultrasound marks were compared, in terms of the time spent in the removal of molten metal cores, and it was observed that there was no significant difference between the equipment tested, taking in average seven min to remove the cores. The ultrasonic energy was maintained until the pin loosening occurred. Lopes et al. [23] (1992) analyzed the time spent for the removal of molten metal pins cemented with zinc phosphate cement in roots of human upper incisors by traction associated with the use of ultrasound, concluding that this method chosen is effective for removal of the pins, reducing by 30% the force necessary for the displacement of the nuclei. Similarly, Berbert et al. [24] (1992) evaluated the influence of the application of ultrasonic energy on the traction removal of metallic cores made from newly extracted human uni-radicular teeth and concluded that the force required for removal of the nuclei is greater when the ultrasound is not applied. In a study carried out by Silva et al. [25], in 2004, the effect of ultrasound application on the force required for the removal of prefabricated and cast copper-aluminum metal pins with different diameters and length was evaluated. The pins were cemented with glass ionomer in endodontically treated teeth. The test groups were divided according to the diameters of the pins, one group receiving ultrasound before the tensile test, while the other did not receive the vibration. The study concluded that the force required for pin removal was significantly lower when the ultrasound was applied, regardless of the pin diameter. Plotino et al. [26] (2007) published an extensive review of the literature on the use of ultrasound in endodontics. Based on the literature review, the authors reported the use of ultrasound as an aid in the removal of fractured instruments and cemented nuclei from the interior of the root canal. They also emphasized the favorable prognosis and the possibility of retreatment without the need for surgical treatment.

This type of in vitro experiment has been commonly performed with natural human teeth, [19,24,27-29] but in the present study we opted for the manufacture of roots in acrylic resin in an attempt to better standardize the specimens, since the human roots present Wide range of formats, sizes and mineral content. Several studies have reported that the type of luting agent can have an influence on the ultrasonic efficiency for post removal. Thus, the vibration is expected to cause the cement to fracture and facilitate the post removal procedure. When an ultrasonic unit is used for post removal, the vibration is transferred to the cement line by the post. Braga 2012 used alternate vibration increases the fragmentation of the zinc phosphate cement, thus favoring the detachment of the intraradicular posts. It has also been postulated that the application of ultrasound tip at the incisal surface maximizes the energy transferred to the post. However, most part of the ultrasonic vibration applied to the cervical extremity of the core was possibly transferred to the post, thus affecting the integrity of the cementing agent and the cohesive/adhesive micromechanical imbrications among post/cement/root canal walls. When the ultrasound was applied to the proximities of the incisal area of the core, a greater loss of transference of ultrasonic energy possibly occurred. Hence, the rupture of the cement was reduced, demanding higher load to remove the intraradicular posts. Further investigations aimed at evaluating other post systems, post depths and types of cements are necessary to confirm the findings. The choice of the molten metal cores was also based on the standardization, since these are customized for each root, thus allowing a minimum cementing line and maximum contact of the pins with the root canal walls. In this way, according to the studies carried out by Berbert et al. [24], Regalo et al. [28] and Tanomaru Filho et al. [29].

Conclusion

Based on the results obtained, we can conclude that the Jet Sonic appliances (Total) and Jet Ultrasound (D700) are similar in efficiency to the removal of fused metal intraradicular root retainers made of acrylic resin. The time spent to remove the nuclei was satisfactory, due to the absence of manual traction, proving the efficiency of the use of ultrasound in the removal of intra-radicular pins and molten metal core, suggesting the association to the manual traction for a reduction in the time spent.

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