EVALUATION OF LATERAL CONDENSATION ENDODONTIC TECHNIQUE WITH 7/D11 SPREADER, FINGER SPREADERS AND AN ULTRASONIC ACTIVATED TIP

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Abstract

The aim of this study was to compare the apical sealing ability, evaluating dye penetration in root canals filled with lateral condensation technique with the use of a 7/D11 spreader, a finger-spreader and an ultrasonic activated tip. 90 distal roots of mandibular first molars were randomly divided into three groups, each with 30 roots. Additionally were used 4 roots as positive control and 4 as negative control. The prepared canals were obturated with lateral condensation technique with sealer and gutta-percha cones condensed with 7/D11 in group 1, finger-spreader in group 2 and a tip activated by ultrasound in group 3. The samples were immersed in India ink and subsequently submitted to a demineralization and clearing process. The extent of dye penetration was measured using a stereomicroscope with software Motic Images Advanced 3.0. The lowest mean leakage values were observed for 7/D11 group and the highest were observed for the ultrasound group. The difference between 7/D11 by one side and finger spreader and ultrasound on the other was statistically significant ($p < 0.05$). Between ultrasonic tip and finger spreader groups the difference was not significant.

Under the conditions of this study it can be concluded that the use of the 7/D11 instrument during condensation of gutta-percha showed better sealing ability by allowing less leakage of the dye between the interphase guttapercha-dentin than finger spreader and the ultrasonic tip.

Keywords: Apical leakage, sealing, spreader, ultrasound

Introduction

The success of endodontic treatment is based on an exhaustive cleaning, shaping, disinfecting and hermetic sealing of radicular canals. The obturation stage involves the complete three-dimensional filling of the root canal system with a stable and biocompatible material to prevent ingress of microorganisms as well as prevent the multiplication of bacteria remaining in the canal, stimulating the periapical healing process after treatment (Cohen, 2002).

Numerous methods have been proposed to fill the root canal. Current techniques are still based on gutta-percha and sealer to achieve this goal; despite the advent of numerous techniques and rotary instrumentation systems the lateral condensation technique remains as a widely used option because of its simplicity and low cost. This technique basically consists of 3 or 4 files used at working length, gates glidden drills to conforming the middle and cervical thirds and a step-back preparation of the apical third combined with profuse irrigation in order to gain a cleaned and shaped space to be filled with gutta-percha condensed laterally (Leonardo, 2005).

In order to perform an adequate sealing of the root canal with lateral condensation technique is necessary to use adequate instruments. Spreaders are commercially available for finger-palm motion as 7/D11 or MA-57. These are long-handled metal instruments, thin, tapered with a dull tip, available in many sizes and angles, used to condense filling materials laterally in the root canal. 7/D11 (Hu-Friedy®, USA) is an instrument that combines the D11 spreader and the 7 plugger design in both extremes of the same instrument (Fig. 1a).

Digital or finger spreaders are manufactured in stainless steel and nickel-titanium. These are pointed and tapered metal shafts with plastic handle useful to open space in depth in a controlled manner, where auxiliary gutta-percha cones need to be inserted during condensation. Digital spreaders (Dentsply/Maillefer), are four instruments in yellow, red, blue and green colors identified by A, B, C, and D respectively, in lengths of 21 and 25 mm (Fig. 1b).

Ultrasound devices may be used in the process of root canal filling with the use of an appropriate tip (Fig 1c). Moreno (1977) reported a technique in which the ultrasound was used to soften the guttapercha during the obturation phase, calling it thermo-mechanical compaction. The size of the heat carrier (ultrasonic tip) can be chosen in different sizes and can be pre-curved replicating the anatomy of the root canal.

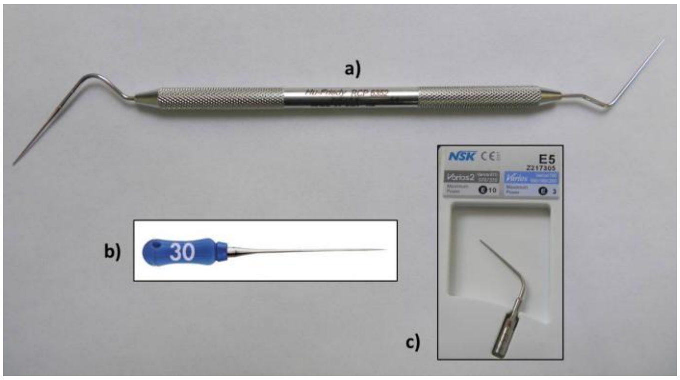


Figure 1. The different instruments used in this study. a) 7/D11 (Hu Friedy, Chicago, IL. USA); b) Finger Spreader (Dentsply-Maillefer, Ballaigues, Switzerland); E-5 ultrasonic plugger (NSK, Osaka, Japan).

Several methods have been used to verify the apical sealing: dye penetration (Zaia, 2002), radioactive isotopes (Dow, 1955), electrochemical filtration (Jacobson, 1976), analysis of bacterial penetration and scanning electron microscopy (Wollard, 1976). One of the most common methods to evaluate the apical filtration is dye penetration of the apex between the dentine surface and the sealing material. The filtration method is considered difficult to evaluate since it involves many variables such as: duct anatomy, cleaning, shaping and obturation technique, physicochemical properties of the sealer employed, irrigating solutions, and whether or not the samples are subjected to vacuum (Spangberg, 1989). Various tracer substances have been used, methylene blue and mainly china ink. Methylene blue has the disadvantage that during the clearing process tends to wash with reagents (Zaia, 2002), however, it has been shown that India ink remains stable throughout the process and is comparable in particle size to bacteria (Chong, 1995), black color allows better visualization during evaluation (Canalda-Sahli, 1997). There are two variants for the immersion of the samples in the dye, these are passive dye penetration and dye penetration through the use of vacuum.

The aim of this study was to evaluate the apical leakage of dye passively using a demineralization and clearing method (Robertson,1980) in distal roots of mandibular molars sealed with gutta-percha and sealer using the 7/D11 spreader, finger-spreader and an E5 compactor activated by ultrasound to condense the guttapercha.

Materials and methods

98 extracted human mandibular first molars were used; ethics approval from the ethics board of the Faculty of Stomatology, University of San Luis Potosí was obtained in order to handle all the dental organs

involved in the study under the legal framework in México. The molars were placed in saline solution until used. The samples were placed in 5% sodium hypochlorite for 15 minutes, to remove organic material from the surface of the roots. The distal roots were removed from the crown at the cement-enamel junction, with a carbide disc (Dentorium, NY, USA) under cold water. Soft tissue and tartar were removed from the outer surface with a #15 scalpel blade (Ribbel, New Delhi, India). A #10 K-file was used (Dentsply/Maillefer, Switzerland) as patency file, visualizing it through the apical foramen and subtracting a millimeter to set a working length, preparation was performed with K files (Dentsply/Maillefer, Switzerland) using three files sequentially greater to conform the apical end and three to perform the step back, using finally a Hedström file (Dentsply/Maillefer, Ballaigues, Switzerland) of a size smaller than the master apical file, irrigation with 3 ml of 1% sodium hypochlorite was made between instruments, and ethanol was used as final irrigant, canals were dried with absorbent paper points (Viarden, México). The 98 roots were randomly divided into three experimental groups, each with 30 roots; control groups included both positive and negative, each with 4 roots. Silco sealer was used (Productos Endodónticos Especializados, SLP, México). Finally, the canals were filled with lateral condensation technique with standardized master cones and fine-fine accessory cones (Hygenic, USA). Thirty roots were obturated with gutta-percha using the 7/D11 spreader (Hu-Friedy, USA), thirty were sealed with finger spreader (Dentsply/Maillefer, Switzerland) and thirty roots were obturated with an ultrasonic E5 tip (NSK, Japan) at a power of 5 for a period of 15 seconds activated with the Suprasson P5 Booster (Satelec-Pierre Rolland, France).

Once obturated, the roots were placed on relative humidity for 7 days, after this period, the roots of the experimental groups were covered with nail varnish (Bissu, México), cyanoacrylate (Industrias Kola-Loka, México) and sticky wax (Geo Cera, Renfert, IL, USA) except for 3mm of the apical area.

The roots of the negative control group were completely covered while the roots of the positive control group were not covered.

The samples were placed in India ink (Pelikan 523, Puebla, México) completely submerged for 5 days, and then washed with tap water for the cervical end until free of external dye. Once sticky wax, varnish and cyanoacrylate were removed with a #15 scalpel blade (Dentorium, NY, USA), proceeded to clearing all the samples. Briefly, were placed in 5% nitric acid for 3 days with acid replacements every 24 hours, then washed with plenty of distilled water for 4 hours, dehydrated with 80% alcohol for 8 hours, followed by 90% alcohol for 1 hour, and 100% alcohol for three hours and finally introduced in methyl salicylate which made the tooth transparent after about two hours.

The dye penetration into the guttapercha-tooth interface was evaluated with a stereoscopic microscope (Leica EZ4D) at 10x with the software Motic Images Advanced 3.0 by an independent evaluator.

Results

The filtration results were evaluated using Fisher's exact test with a significance level of $p < 0.05$; were considered the points of maximum penetration on both sides of each sample. Values are expressed using descriptive statistics, showing the measures of central tendency in Table 1.

Group	n	Mean ± standard deviation	Media	Maximum value	Minimum value
7/D11	60	1.07	1.14	5.08	0.13
Finger-Spreader	60	1.47	1.26	6.21	0.07
Ultrasonic Tip	60	1.78	1.98	5.76	0.06

Table 1. Dye penetration in the experimental groups; data expressed in millimeters; $p < 0.05$ Fisher exact test.

Negative control showed no dye penetration whereas the positive control showed dye penetration along the entire length of the root. The measurements of dye penetration in the samples were expressed in millimeters, the figure 2 shows examples of minimum penetration of dye for 7-D11 group in a), finger spreader group in b) and ultrasonic tip in c); while examples of greater penetration for the three groups are shown in d, e, and f respectively.

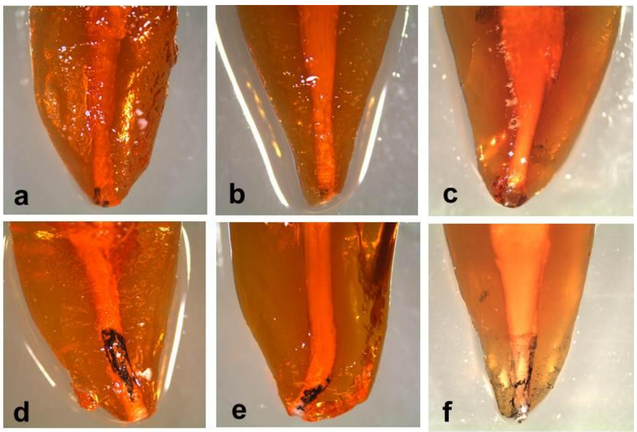
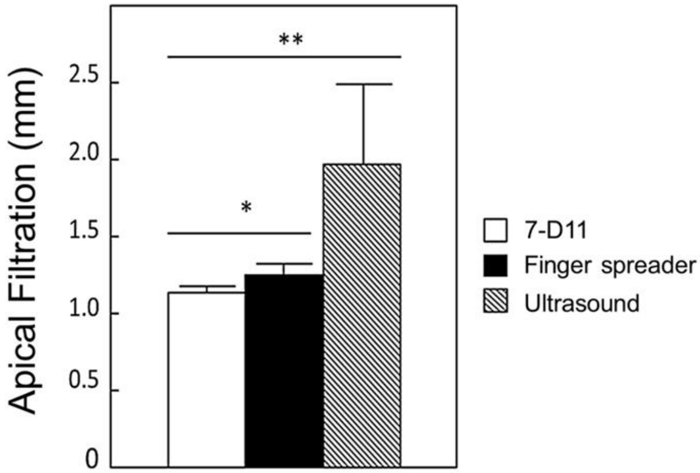


Figure 2. Photomicrographs of dye penetration level in diaphanized roots, 10x. Minimal penetration examples: a) 7-D11; b) finger spreader; c) ultrasonic tip; and representative images of maximum dye penetration, d) 7/D11; e) finger spreader; f) ultrasonic tip.

Data analysis

The results indicated a minimum value of 0.13 and a maximum value of 5.08 with a mean of 1.14 for the 7/D11 group. The finger spreader group showed a range from 0.07 to 6.21 with a mean of 1.26. The ultrasonic tip group showed a range from 0.06 to 5.76 with a mean of 1.98. The results showed increased dye penetration through the interface guttapercha-dentin for the finger-spreader group compared with the 7/D11 group. The comparison between both groups resulted in a statistically significant difference ($p < 0.01$). While greater dye penetration through the interface in the ultrasound group compared with those sealed with the 7/D11 was observed. The comparison between both groups resulted in a significant difference ($p < 0.001$). The level of significance between the treatments carried out with finger-spreader compared with ultrasound was $p < 0.17$**.** The degree of leakage at the interface dentin guttapercha resulting from the comparison between groups is shown in Graph 1.



Graph1. Degree of leakage at the interface gutta-dentin from the comparison between groups: 7/D11, finger spreader and ultrasonic activated tip. Values represent the mean ± standard deviation (SD) with n=60 for each treatment. In the comparison between 7-D11 and finger-spreader the level of statistical significance was $p < 0.01$ *. With regard to the comparison between ultrasound and 7/D11 the level of statistical significance was $p < 0.001$ ** and finally between finger-spreader and ultrasound was $p < 0.17$.

Discussion

The sealing of the root canal system is a cornerstone in the success of endodontic treatment, preventing the entry of interstitial fluids and hence the risk of penetration of microorganisms and their toxins that cause the possibility of failure. One of the methods to evaluate the apical sealing is diaphanisation or clearing technique, which shows the extent of filtration of a dye and possible sealing defects, as a result of passive or vacuum assisted filtration. Authors like Spangberg (1989) showed that in studies without vacuum, the defects between the filling material and cavity walls could entrap air preventing the entry of dye; but Goldman (1989) conducted a study comparing the degree of filtration in canals sealed and unsealed, under vacuum conditions or passive determining no statistical difference in the degree of filtration.

The results obtained in the negative and positive controls indicate that the model used was suitable for the purpose of this study. Jerome (1988) found less filtration after condensation using finger-spreader compared with the D11, while Simons (1991) reported lower filtration employing finger spreaders compared with spreader for finger-palm motion. Ultrasound has been used with lateral condensation to thermo plasticize gutta-percha in *in vitro* experiments showing to be superior than conventional lateral condensation with respect to the sealing properties and density of the guttapercha, Baumgardner (1990) using ultrasound and a spreader specially adapted showed lower filtration compared with the lateral condensation which is not consistent with our results that showed less leakage at the interface gutta-percha dentine when the 7/D11 was used. Has been reported that the warm condensation of gutta percha produces less leakage compared with the lateral condensation (Kersten, 1988). However it is recognized that the ultrasonic warm condensation of guttapercha is one of the best methods available to replicate intrinsic duct areas, but due to its characteristics of fluidity is difficult to control it in the apical area (Robertson, 1980). It is important to take into consideration the time and activation power of the equipment (Bailey, 2004). The clearing or diaphanisation method is better than the longitudinal sectioning of the roots due to tooth structure loss during the cutting, the need of additional cuts in curved canals, and the difficult of three-dimensional evaluation (Gilhooly 2001). The diaphanisation method has proven effective in filtration studies because permit to evaluate filtration in three dimensions, preserves the intact samples, is simple, and frequently used (Canalda 1997, Lee, 2002, O´Neil, 1983). The authors agree with this approach because it allows having a complete picture of the apex in three dimensions enabling the evaluation of any point of filtration of the tracer. Some of the factors that can influence the results of this kind of study are: changes in the samples, operator skill, a better training in handling a specific instrument and the force applied to it, according to Harvey (1981) in respect to the different handling and ergonomics, the average force applied to the spreaders during lateral condensation can vary from 1 to 3 kg in the test methods, In view of these factors it is imperative to be cautious and more studies controlling as many variables as possible must be desirable.

Conclusion

The use of three instruments, the 7/D11 spreader, the finger-spreader, or the ultrasonic tip can help to shape a homogeneous mass of gutta percha as a part of the lateral condensation technique. Under the conditions of this study it can be concluded that the use of the 7/D11 instrument during condensation of gutta-percha showed better sealing ability by allowing less leakage of the dye between the interphase guttapercha-dentin than finger spreader and the ultrasonic tip.

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