IN VITRO EVALUATION OF THE OBTURATION ABILITY, ADAPTATION AND COMPACTION OF GUTTA-PERCHA IN THE ROOT CANAL SYSTEM EMPLOYING DIFFERENT FILLING TECHNIQUES

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ABSTRACT

The aim of this study was to evaluate the in vitro obturation quality of four filling methods: active lateral condensation, a modification of Tagger's hybrid technique, ENAC ultrasound technique and the Microseal technique. The study was performed on one hundred and sixteen single-rooted human teeth, divided into four groups of twenty nine teeth, embedded in resin, longitudinally sectioned and placed together on a wooden device with screws. After instrumentation, a cavity was made with a bur in the cervical, medium and apical thirds of the root canal in order to simulate lateral canals. The teeth were filled with the different techniques. Obturation quality was evaluated employing photographs and radiographs. The statistical analysis using the Chi square (χ^2) test revealed that the Microseal technique reached the best results followed by the modified Tagger's hybrid technique, the ENAC ultrasound technique and the active lateral condensation technique.

Key words: *Endodontics, root canal filling, gutta-percha.*

EVALUACIÓN *IN VITRO* DE LA CAPACIDAD DE OBTURACIÓN, ADAPTACIÓN Y COMPACTACIÓN DE LA GUTTA-PERCHA EN EL SISTEMA DE CONDUCTOS RADICULARES POR DIFERENTES TÉCNICAS OBTURADORAS

RESUMEN

El objetivo de este estudio fue evaluar la obturación in vitro del conducto radicular bajo las técnicas de condensación lateral activa, híbrida de Tagger modificada, ultrasonido Enac y Microseal. Fueron empleados ciento dieciséis dientes humanos uniradiculares, divididos en cuatro grupos de veintinueve dientes, seccionados longitudinalmente, los cuales fueron fijados en bloques de resina y posteriormente unidos en un dispositivo de madera con tornillos. Después de la instrumentación, y con la ayuda de fresas, fue confeccionada una depresión en cada tercio del conducto radicular. Finalmente, los dientes fueron obturados con las citadas técnicas. Para evaluar la calidad de la obturación, fueron realizadas fotos con aumento de 1,5x y radiografías. Después del análisis estadístico macroscópico y radiográfico por medio del test Chi cuadrado (χ^2), la técnica Microseal presentó mejores resultados en cuanto a la capacidad de obturación, homogeneidad y menor número de fallas, seguida de las técnicas híbrida de Tagger modificada, ultrasonido Enac y condensación lateral activa.

Palabras clave: *Endodoncia, obturación del conducto radicular, gutapercha.*

INTRODUCTION

The success of endodontic therapy is based on the knowledgeable implementation of the different stages of endodontic treatment, including the tridimensional obturation of root canals [1-3].

Adequate obturation of the root canal system provides mechanical barrier, preventing bacterial re-infection in the root canal system (R.C.S.), which could otherwise impair apical and peri-apical repair post-endodontic treatment. A faulty obturation will allow the fluids of peri-apical tissues to invade the resulting spaces, potentially becoming infected by bacteria that enter by a retrograde route or through faulty restorations in the oral cavity [4-7]. Faulty Obturations and incomplete sealing result in permeable root canal seals and are responsible for a large fraction of endodontic failures [8-12].

Since the introduction of gutta-percha in dental practice in 1867, it became the material of choice

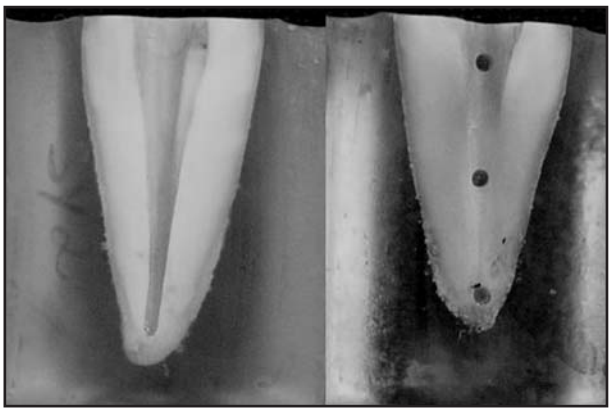

Fig. 1: Vestibulo-lingual section of a tooth exhibiting the perforations performed to simulate lateral canals.

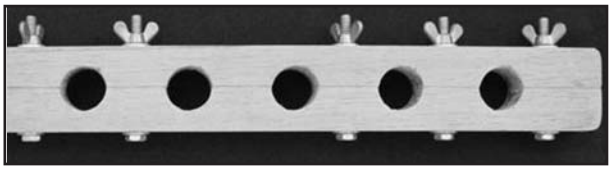

Fig. 2: Wooden device with screws.

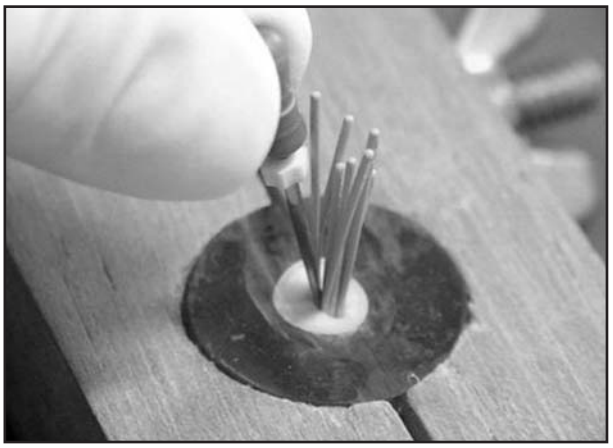

Fig. 3: Tooth and resin block repositioned in the wooden device for instrumentation and obturation.

for the obturation of root canals. However, a major disadvantage of this material is its lack of adhesiveness, making it difficult to manipulate, condense and adapt to the walls of the root canal. To improve the quality of root canal filling, new obturation techniques and systems that employ thermoplasticized gutta-percha were developed.

Given the wide variety of thermoplastic techniques, the present *in vitro* study comprised a macroscopic and radiographic evaluation in human teeth of the obturation capacity, defects and degree of homogeneity of different thermoplastic gutta-percha obturation techniques, i.e. a modification of Tagger's hybrid technique, ENAC ultrasound and Microseal techniques, compared to the traditional lateral condensation technique.

MATERIALS AND METHODS

One hundred and sixteen single, straight-rooted human teeth, i.e. upper central incisors and upper canines, were employed throughout the study, immediately post-extraction. The roots were embedded in polyester blocks (Milflex Indústrias Químicas Ltda, São Bernardo do Campo, SP, Brazil) and the dental crowns were sectioned at the level of the cement-enamel junction with a diamond disc using a ISOMET 1000 machine (Buehler, Lake Bluff, IL, USA). The length of the roots was established at 17 mm. The full length of the roots was sectioned longitudinally in the vestibulo-lingual direction with a diamond disc in an ISOMET 1000 machine (Fig. 1). The sectioned slices were rejoined employing a wooden device with screws for subsequent instrumentation, obturation, establishment of the apical stop and the root canal shape (Figs. 2 and 3). The teeth were divided into 4 groups of 29.

Working length determination was performed with a #15 K file (Kerr Corporation, Romulus, MI, USA), reducing the true tooth length (TTL) by 1 mm. The sectioned slices were joined immediately in the wooden device in order to perform the biomechanical preparation of the root canals with a #1 Peeso bur (Les Fils d' Auguste Maillefer SA, Switzerland) at the level of the true working length (TWL) to standardize the root canals. Preparation was completed with Profile instruments 0/04, 25/04, 30/04 (Dentsply-Maillefer, Ballaigues, Switzerland) powered with an electric motor Endo Plus (VK Driller, Sao Paulo, SP, Brazil) at the level of the TWL. The #60 K file was used at the level of the TWL to refine the apical stop and a #15 K file was used at the level of the TTL to remove possible dentine debris. Between the use of the different instruments, profuse irrigation with 0.9% physiologic saline was performed (Laboratório Sanobiol Ltda, São Paulo, SP, Brazil). The smear layer was removed with EDTA (Biodinâmica Química e Farmacêutica, Ibiporã, PR, Brazil) applied for three minutes, followed by washing with 0.9% saline solution. The root canals were dried with aspiration cannulae

and paper points (Tanariman Indústria Ltda, Manacapuru, AM, Brazil).

Once the biomechanical preparation was completed, a 0.5 mm cavity was excavated in each root third, in one half of each root, with a spherical bur Carbide #1 (S.S. White Artigos Dentários, Ltda, RJ, Brazil). Half of the active portion of the bur (Fig. 1) was introduced into the depression (Fig. 1), followed by a troncoconic bur CA #170 L (KG Sorensen**,** São Paulo, SP, Brazil), to evaluate the expelling capacity of the cavity This procedure was followed by profuse irrigation and drying of the root canal.

The teeth were re-positioned in the wooden device and obturated in keeping with the instructions of the manufacturers and of the authors of each of the techniques, without employing sealer (Fig. 3): Group I – active lateral condensation – with a main gutta-percha cone #60 (Tanariman Indústria Ltda, Manacapuru, AM, Brazil) in the TWL and accessory cones B8 (Tanariman Indústria Ltda, Manacapuru, AM, Brazil); Group II – modification of Tagger's hybrid technique – with main gutta-percha cone #60 in the TWL, accessory cones B8 and the McSpadden #70 compactor (Les Fils d' Auguste Maillefer SA, Switzerland) 2 mm short of the TWL; Group III – ultrasound ENAC technique – with the main gutta-percha cone #60 in the TWL and an ultrasound ENAC #30 tip (Osada Eletric Co. Ltd, Japan), set at power five for lateral condensation of the gutta-percha. The space created by the ultrasound facilitated the placement of the B8 accessory cones. The ultrasound was employed once again until the #30 tip had penetrated 3 mm into the root canal; Group IV – Microseal technique– MicroFlow #60 main cone (Tycom, Irvine CA, USA) heated for 45 seconds and placed in the TWL. Immediately after this procedure a McSpadden #70 compactor (Les Fils d' Auguste Maillefer SA, Switzerland) was applied for six seconds, 2mm short of the TWL.

After the obturation of the root canals, the roots were removed from the wooden device. During removal, it was possible to see the obturation of the cavities prepared in one portion of the root.

The quality of obturation was evaluated employing photographs of the samples at a 1.5 magnification and radiographs.

The photographs were scored according to the following criteria [13]:

A. Obturation of the cavities:
0 = none of the cavities were reproduced in the obturation; 1 = one or more cavities were partially reproduced; 2 = one of the three cavities was reproduced; 3 = two cavities were reproduced; 4 = three cavities were reproduced.

B. Defects in obturation:
0 = evidence of two or more areas with faulty adaptation to the root canal wall; 1 = single area with faulty adaptation; 2 = no area with faulty adaptation.

C. Degree of obturation homogeneity:
0 = unequivocal evidence of auxiliary individual cones, area with void or visible folding of gutta-percha; 1 = partial evidence of auxiliary individual cones, area with void or visible folding of gutta-percha; 2 = homogeneous surface of gutta-percha, with no visible deformation.

The radiographs were scored as follows:

A. Obturation of the cavities:
0 = none of the cavities were reproduced in the obturation; 1 = one or more cavities were partially reproduced; 2 = one of the three cavities was reproduced; 3 = two cavities were reproduced; 4 = three cavities were reproduced.

B. Defects in obturation:
0 = evidence of two or more areas with faulty adaptation to the root canal wall; 1 = single area with faulty adaptation; 2 = no area with faulty adaptation.

Statistical analysis of the results was performed.

RESULTS

Statistical analysis of the data was performed employing the Chi square test (χ^2), setting the level of statistical significance at (p=0.05). The Microseal technique exhibited the best results concerning the obturation capacity, less faults and degree of homogeneity ($p<0.05$), (Fig. 4) followed by the modification of Tagger's hybrid technique (Fig. 5) and the ENAC ultrasound technique (Fig. 6). The active lateral condensation technique (Fig. 7) exhibited the least favorable results ($p>0.05$), as revealed by Figs. 8 and 9.

Fig. 4: Microseal technique.

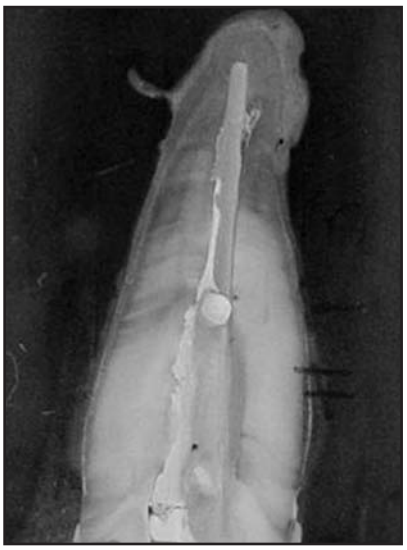

Fig. 5: Modification of Tagger's hybrid technique.

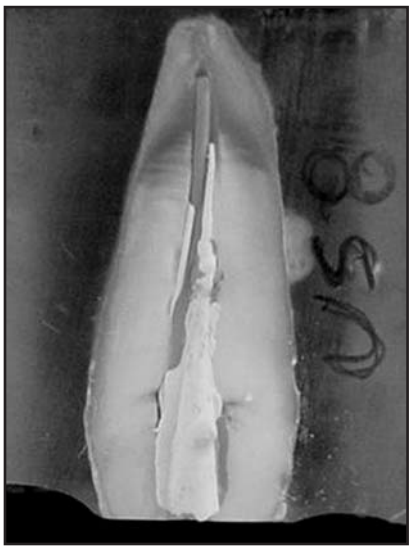

Fig. 6: Ultrasound ENAC technique.

Fig. 7: Active lateral condensation technique.

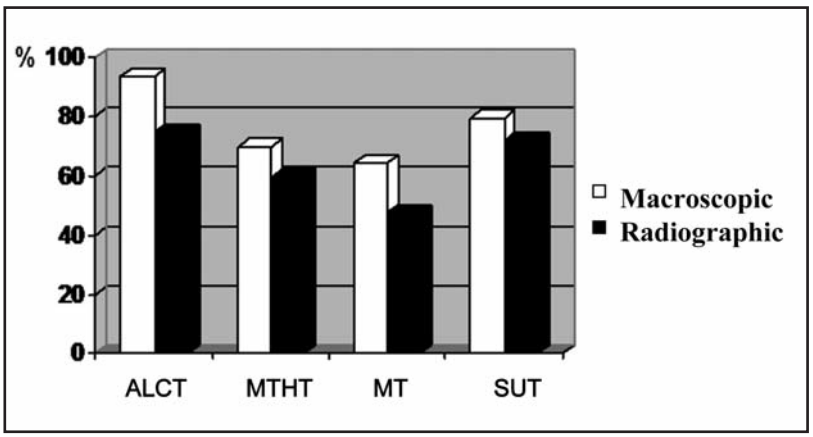

Fig. 8: Macroscopic and radiographic relative percentage frequency (%) of lack of obturation in the cavities and defects employing the different techniques: active lateral condensation technique (ALCT), modification of Tagger's hybrid technique (MTHT), Microseal technique (MT) and ultrasound technique (UST).

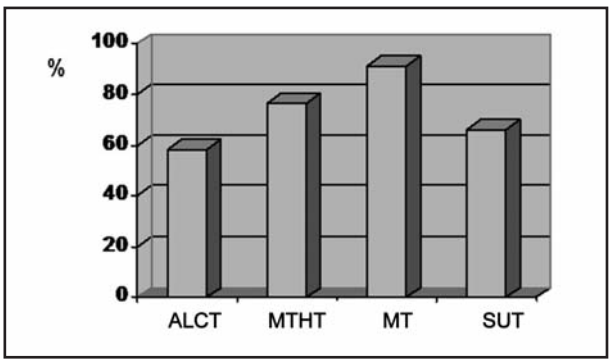

Fig. 9: Relative percentage frequency (%) of degree of homogeneity employing the different techniques: active lateral condensation technique (ALCT), modification of Tagger's hybrid technique (MTHT) (THTM), Microseal technique (MT) and ultrasound technique (UST).

DISCUSSION

Many failures in endodontic treatments are attributed to incomplete obturation of the R.C.S. [5], due to the difficulties involved in three-dimensional obturation. The complexity of the R.C.S. is well known [14-19].

Thermocompaction can increase the density and homogeneity of the gutta-percha mass compared to the active lateral condensation technique [20-21]. These techniques exhibit a greater capacity to allow gutta-percha to flow into the irregularities of the root canal [22-23].

In the present study we employed cavities prepared in the different thirds of the root canal because we

consider that the obturation that results from filling these irregularities will also be able to fill the lateral and accessory canals, yielding data that will serve to evaluate the obturation capacity of each of the techniques examined.

The use of gutta-percha without cement produces incomplete sealing of the root canal. Root canal sealers are necessary to adhere gutta-percha to dentine and contribute to the obturation of the irregularities [24]. In fact, we did not use sealer due to this effect. The methodology employed in the present study involved obturation, joining of the teeth in the wooden device, and separation for final evaluation. The use of cement could preclude this final separation of the slices with the obturations and interfere with the observation of the filling of the cavities, faults and degree of homogeneity of the obturation mass.

The apical seal is as important as the coronal seal. Teeth with root canals exposed to bacteria at the coronal level exhibit apical contamination [6, 25, 26], confirming the importance of the achievement of a homogeneous mass filling the cervical, middle and apical thirds of all the R.C.S.

We used methodology a method that resembles that employed in previous studies [13, 27], i.e. use of human teeth embedded in resin, and preparation of irregularities in longitudinal sections of the teeth that contribute to data analysis. We also performed a radiographic evaluation of the obturations as in a previous study [28], employing similar criteria to those employed in macroscopic assessment.

Due to the large number of teeth employed in the present study and the need to standardize the biomechanical preparation, we employed the #1 Peeso bur in the TWL, established with a #15 K file [29]. The use of the Profile instrument conferred a more conical shape on the root canals and corrected the grooves caused by the Peeso bur.

The manual #60 K file was employed to refine the apical portion of the preparation and the file K #15 was employed to remove the debris that accumulated during instrumentation of the apical region [13, 30].

The present study employed natural extracted teeth, according to the international consensus [30-34]. Natural teeth are most frequently used in *in vitro* studies. There is a clear tendency towards the use of uniradicular teeth [24, 35, 36]. We employed upper central incisors and upper canines, excluding those with some degree of curvature, wide canals or canals that were far from the apex.

In order to study the described obturation techniques we employed the active lateral condensation technique as control, one of the most widely known and used techniques [37, 38].

The modified Tagger's hybrid technique [39] uses McSpadden compactors which are similar to an inverted *Hedströen* file, unlike *Enginers Pluggers*.

The results were evaluated employing an x1.5 magnifying glass to observe the photographs of each section in conjunction with the radiograph of each tooth.

The results revealed that the lateral condensation technique was the only one that produced partial filling, both macroscopically and radiographically, of the three cavities prepared in the root canals. Regarding homogeneity, because this is not a thermoplastic technique, it exhibited more individual auxiliary cones but achieved a better apical seal.

Fig. 1 shows that fewer defects were detected at a radiographic level than at a macroscopic level. This is due the fact that the radiographic image is projected in one plan, masking potential defects.

Regarding the obturation of the three cavities, the active lateral condensation technique exhibited the least favorable results both at a macroscopic and radiographic level. However, concerning the homogeneity and fewer defects, the modified Tagger's hybrid technique was only less favorable than the Microseal technique, the best technique in terms of all the end-points evaluated.

The ultrasound technique exhibited more favorable results than the active lateral condensation technique concerning the obturation of the cavities, defects and homogeneity. Ultrasound vibration produced sufficient heat to plastify the gutta-percha, but insufficient heat to fully plastify the auxiliary cones. The ultrasound technique and the active lateral condensation technique produced the least favorable results concerning the homogeneity. The ultrasound technique produced an adequate apical seal.

The comparative evaluation of the Microseal technique and the other techniques under study revealed that both macroscopically and radiographically, the Microseal technique is the most favorable concerning the obturation of the cavities, exhibiting fewer defects and better homogeneity.

The association of the obturation cement with the gutta-percha will improve sealing. The cement will

penetrate where the gutta-percha cannot, obturating the defects caused by each of the techniques.

CONCLUSION

By employing the methodology described, we can conclude from the present results that in terms of filling of the cavities and defects and degree of obturation homogeneity, the Microseal technique was the best, both macroscopically and radiographically, followed by the modification of Tagger's hybrid technique, the ENAC ultrasound technique and lastly, the active lateral condensation technique.

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