EFFICACY OF THREE THERMOPLASTIC OBTURATION TECHNIQUES IN FILLING OVAL-SHAPED ROOT CANALS

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ABSTRACT

The purpose of this study was to assess the efficacy of the thermoplastic filling techniques, Touch'n Heat®, TC® System and Tagger's Hybrid Technique, in oval-shaped canals at the apical third.Thirty-three human uniradicular lower pre-molar teeth were treated by the reciprocating movement technique and were subsequently split into 3 groups, according to the filling technique performed:Touch'n Heat (TH), TC System (TC) and the Tagger's Hybrid Technique (TG).In the sequence, the teeth were sectioned at 2mm and 4mm from the foramen and images were taken to measure the percentage of canal area filled with the obturation materials as well as void spaces.Data were submitted for Kruskal-Wallis statistical analysis. Irrespective of levels, data showed that the TC System delivered the best results.(p<0,001).At 2mm and 4mm levels, there was no difference between the TG technique and the TH technique (p<0,001).With all the techniques and at all levels, no differences were observed regarding the void area variable.(p>0,001).The techniques evaluated showed an adequate filling with obturation materials and the TC has reached the highest filling with the guta-percha material.

Key words: *Endodontics; root canal therapy; dental materials.*

EFETIVIDADE DE TRÊS TÉCNICAS DE OBTURAÇÃO TERMOPLÁSTICAS NO PREENCHIMENTO DE CANAIS OVAIS

RESUMO

O objetivo desse trabalho foi avaliar a eficiência de preenchimento das técnicas termoplásticas Touch'nHeat®, Sistema TC® e Híbrida de Tagger em canais de anatomia oval no terço apical. Trinta e três dentes pré-molares inferiores humanos unirradiculares foram instrumentados pela técnica do movimento reciprocante e posteriormente separados em 3 grupos segundo a técnica de obturação: Touch'nHeat, Sistema TC e Híbrida de Tagger. Em sequência os dentes foram seccionados nos níveis de 2 mm e 4 mm a partir do forame e imagens foram capturadas para mensurar a porcentagem da área do canal preenchida com os materiais obturadores e os espacos vazios. Os dados foram tabulados e submetidos ao teste estatístico de Kruskal-Wallis. Independente dos níveis, os dados mostraram que a TC apresentou os melhores resultados. (p<0,001). Nos níveis de 2 e 4mm não houve diferença entre as técnicas TG e TH (p<0,001). Em todas as técnicas e níveis não foram observadas diferenças com relação a variável áreas vazias. (p>0,001). As técnicas avaliadas demonstraram um adequado preenchimento pelos materiais obturadores, com destaque para o preenchimento superior com guta-percha pela técnica TC.

Palavras chave:*Endodontia;obturação do canal radicular; materiais.*

INTRODUCTION

The main strategy followed for removing microorganisms from root canal systems is chemo-mechanical debridement. Yet, due to the acknowledged anatomical complexity of pulp cavities, microorganisms still remain inside them after the chemical and mechanical preparation stages. Thus, through obturation, periradicular tissues are sealed to prevent the presence of such residual microorganisms[1].

Filling materials frequently used for obturation practices are gutta-percha and endodontic sealer. There are several different obturation techniques. The major difference among them is the way in which gutta-percha is used for filling in combination with sealer. Lateral Condensation (LC) is a very popular technique as it is quite safe in order to control of the root canal filling[2], yet, it has been proved that LC does not effectively fill root canal systems and frequently leaves void spaces and a not too homogeneous distribution of sealers[3,4]. Thermoplastic gutta-percha techniques have been performed in most of the treatments due to its advantages for not being too time-consuming and for delivering better filling levels, compared with the LC technique[4-7].

There are several different systems for plasticizing gutta-percha. The main advantage of Touch´n Heat®

(Analytic Endodontics, Orange, CA) is that it is a simple technique[8].

Tagger's Hybrid technique uses stainless steel or nickel-titanium rotary instruments, the gutta condensors for mechanically plasticizing gutta-percha cones[9].This technique is quite widespread, but not easily accepted, mainly by students, because its execution is not easy and because of possible accidents and complications when performing this technique.

The TC® System (Tanaka de Castro & Minatel Ltda., Cascavel, PR, Brazil) consists in filling canals with previously plasticized gutta-percha in a specific heating device[10].This is a Brazilian system, not very popular, and its execution requires some degree of training, but it has showed relevant in vitro results in relation to other thermoplastic techniques due to the optimal filling of root canals[6,7,11].

Even if filling of canals through thermoplasticized gutta-percha gives excellent results, with oval-shaped canals this is still a difficult task[12,13]. The main thermoplastic techniques are now widely used due to their better filling levels, yet, their quality depends on the shape of root canals[11].

Considering the growing acceptance and use of thermoplastic obturation techniques, the present study was designed for assessing the filling efficacy of thermoplastic techniques such as Touch'n Heat®, the TC® System and the Tagger's Hybrid in oval-shaped canals.

MATERIALS AND METHODS

This study was submitted to the Ethics Committee for Research in Human Beings of the Federal University of Mato Grosso do Sul (UFMS) and was approved with Approval # CAAE 42313214.9.0000.0021.

Thirty-three human uniradicular pre-molar lower teeth, extracted for different reasons, were used in the study.The initial length and the verification of presence of a single canal, the absence of root fractures and the complete formation of the apex, were analyzed, both by visual inspection and through X-Rays.The oval-shaped anatomy of these teeth was evaluated by Cone Beam Tomography (I-cat, Kavo Kerr, Germany).Thus, through axial sections, rounded canals were checked for and rejected, and only oval-shaped canals in the third apical of root canals (5mm apical of root) were considered for standard samples.

The root canals were prepared with the Reciproc® System (VDW, Munich, Germany), up to the R40 file size, as the initial apical instrument has traditionally been a hand-held ST K#20 file (VDW, Munich, Germany).Sodium hypochlorite (2.5%) was used as auxiliary chemical irrigating solution during the procedure, with an approximate solution volume of 20 ml. per canal.Before obturation, passive ultrasonic irrigation (PUI) was performed, the solution was shaken by a specific ultrasonic tip - *irrisonic* (Helse, Ind.& Com., Santa Rosa de Viterbo-SP, Brazil) coupled to a Jet Sonic ultrasonic device (Gnatus, Ribeirão Preto, Brazil) with the following sequence:irrigation with 2,5% sodium hypochlorite and ultrasonic 20-second activation, flooding with EDTA Trisodium (Biodinâmica, Ibiporã-PR, Brazil); again, a 20-second activation and, once again, irrigation with 2,5% sodium hypochlorite and ultrasonic 20-second activation, totaling a 1-minute activation of the irrigating solution. In the sequence, the canals were thoroughly irrigated with 10 ml of saline solution.

After preparation, as described above, the specimens were randomly distributed into 3 groups, according to the obturation technique being tested:Group 1 (TC® System), Group 2 (Touch´n Heat® System), and Group 3 (Tagger's Hybrid Technique), each group having 11 specimens.The endodontic sealer used was AH Plus® (Dentsply Maillefer®, Ballaigues, Switzerland).

Group 1:TC® System (TC)

After drying the canal, the endodontic sealer (AH plus®) was introduced with a paper cone having the same diameter of R40 file within the canal, in the working length.The TC® System syringe was placed in the heating device.After indication of plasticizing of the gutta-percha (Average: 2.5 minutes), a ST #25 gutta-condensor (Dentsply Maillefer®, Ballaigues, Switzerland) was coated, in its active part, with the plasticized gutta-percha and was immediately introduced and activated at a 10,000 rpm speed with short in/out movements (piston movements), turning in a clockwise motion until reaching approximately 1mm shorter than working length.It was then immediately withdrawn against one of the canal walls, also using "piston movements".This procedure took approximately 5 seconds. After removing the gutta-condensor from the canal, a vertical condensation was performed with a cold hand plugger until the gutta-percha was entirely cooled down (hardening of the material).

Group 2: Electrical heat source Touch´n Heat® (TH) Prior to obturation, the tip of the device was selected so that it would reach up to 5mm shorter than working length.The power level that was used was 10 (200°C).Working in a sequence, the master M gutta-percha cone (Odous De Deus®, Belo Horizonte-MG, Brazil), tip #40, corresponding to the shape left by the R40 Reciproc file, was introduced, coated with the sealer (AH Plus®), with in/out motions so as to contact all the canal walls and reach the working length.The following step was activating the tip that was advanced through the gutta-percha cone in a single motion until reaching the 5mm limit shorter than the working length.At this moment, the heating process was interrupted and pressure was kept stable until completing the 10-second lapse, which lapse was comprehended from the onset of the procedure. After this, the device pen was tapped again for resuming heating and for withdrawing the tip from the root canal.In the sequence, cold hand pluggers were used for vertical condensation.

Group 3: Tagger's Hybrid Technique (TG)
The adaptation of the master M gutta-percha cone (Odous De Deus®, Belo Horizonte-MG, Brazil) was performed by adjusting its gauge at #40; the cone was coated with sealer (AH Plus®), and both the gutta-percha and the sealer were introduced into the root canal, as described with Group 2. By using digital spacers, some secondary XF gutta-percha cones (Dentsply Maillefer®, Ballaigues, Switzerland) were added.The number of these cones varied according to the gauge of the root canal subject to obturation, thus offering a supply of gutta-percha enough for filling the apical third.
Immediately after this, a gutta-condensor was selected, its gauge two numbers above the gauge of the master gutta-percha cone, that is, # 50 (Dentsply Maillefer®, Ballaigues, Switzerland).Then, the compacter was inserted until reaching resistance, and turned on at a clockwise rotation at 10,000 rpm, with to-and-fro movements until reaching a 3mm depth shorter than the working length.After withdrawing the compactor from the root canal, a vertical condensation procedure was performed with cold hand pluggers.
After obturation, the specimens were kept in a heating device at 37°C, with 100% humidity levels for seven days.After that period, the roots were measured with a digital caliper (Black Bull, USA) and marked at 2mm and 4mm from the apical foramen.The sections were made with a double face diamond disk # 7020, width: 0.10mm ((KG Sorensen, Cotia-SP, Brazil), assembled on a handpiece at 10,000 RPM and under constant cooling conditions derived from the handpiece and an additional water jet directed towards the section area.The resulting sections were fixed on the microscope stage (Carvalhaes, Gravataí-RS, Brazil) with *blu tac* (Bostik, UK).This helped correcting any tilting of the specimens for getting a better focus of the Stereoscopic Magnifying Glass (Coleman, Santo André-SP, Brazil). The sections were examined with a 40-times magnification, and images were taken with a digital camera (Cyber-Shot DSC-WX10, Sony, Japan).
Images were measured with software Axion Vision LE (Carl Zeiss, Thornwood-NY, USA), where the total area of the canal was gauged, as well as the voids and areas filled with gutta-percha and sealer.Measures were taken at a 1:1 scale on the inserted images, and pixels were estimated.Such measures were transformed into percentages of void areas, and sealer and gutta-percha filled areas. (Fig. 1)

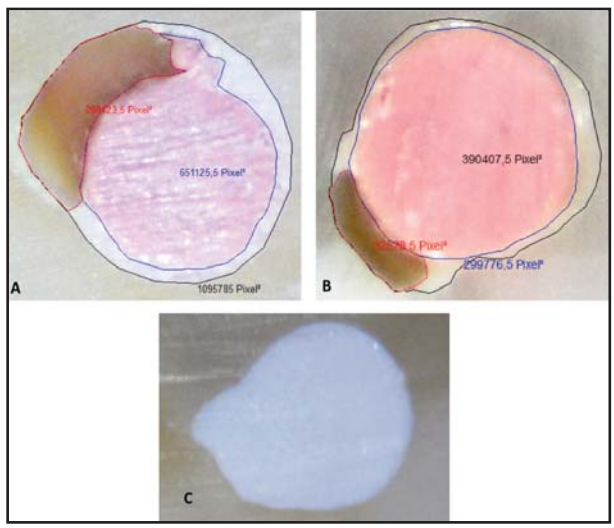

Fig. 1: Void area contoured by the red line; the blue line shows the limit of the gutta-percha, and the black line shows the total canal area.The endodontic sealer was calculated based on the remaining area (Sealer Area = [Total Area – (gutta percha + void area)].2mm Level, "A" Tagger's Hybrid Technique, and in "B", the Touch'n Heat, and in "C", the TC System with the entire canal area filled with gutta-percha. The measurements was made in pixels.

In the statistical analysis done for comparing the different techniques, the Kruskal-Wallis test with a significance level of 5% ($\alpha = 0,05$) was used.

RESULTS

When the different techniques were evaluated, irrespective of levels, data showed that the TC System delivered the best results.($p<0,001$).At 2mm and 4mm levels, there was no difference between the TG technique and the TH technique ($p<0,001$).With all the techniques and at all levels, no differences were observed regarding the void area variable.($p>0,001$).

Data of the filling percentages of gutta-percha, sealer and void areas, obtained from the two assessed levels, groups TC, TG and TH are shown in Fig. 2, 3 and 4.

DISCUSSION

One of the factors that may have an impact on the filling supplied by obturation was related to root canal anatomy.Oval-shaped canals are difficult to clean and fill[14]. In this regard, three obturation techniques were evaluated, that used thermoplasti-

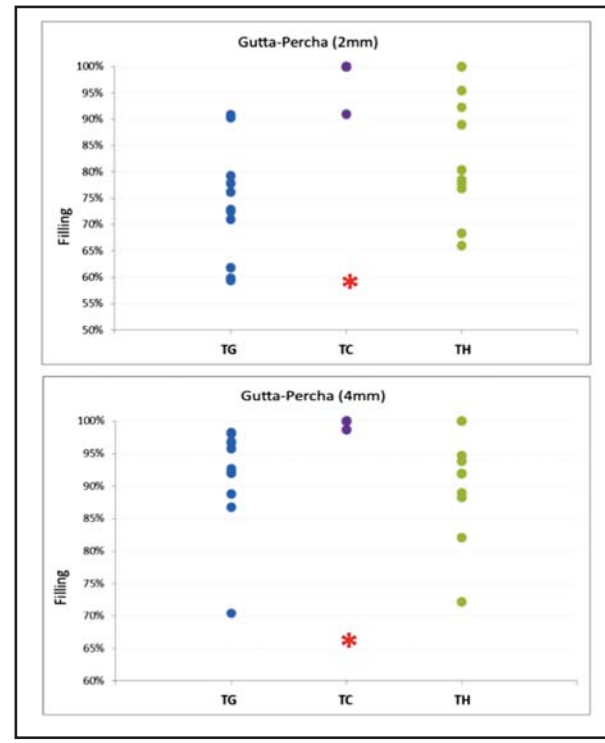

Fig. 2: Graphs show the filling percentages with gutta-percha in both levels (2mm and 4mm). represents the technique that was statistically different from the other techniques.*

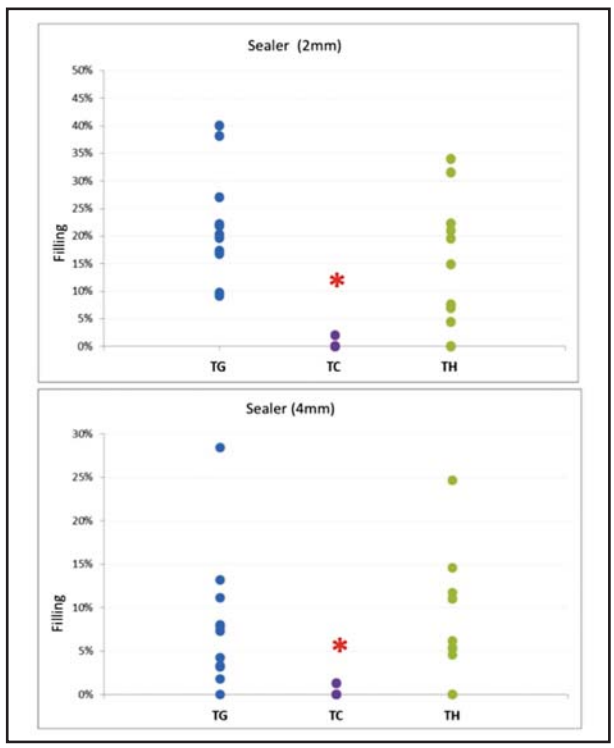

Fig. 3: Graphs show the filling percentages with sealer in both levels (2mm and 4mm). represents the technique that was statistically different from the other techniques.*

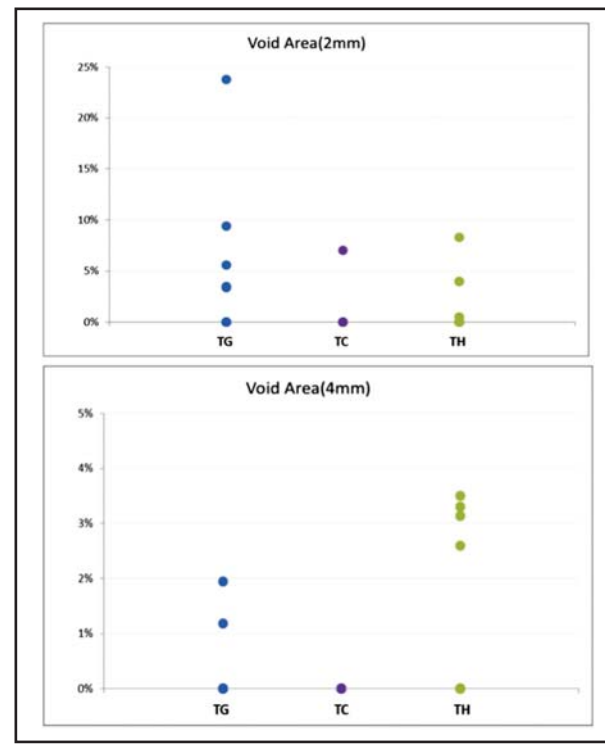

Fig. 4: Graphs show the percentages with void areas in both levels (2mm and 4mm).

cized gutta-percha in human lower pre-molar teeth with an oval cross-section at the apical third.

For obtaining the sections to be analyzed, a highly thin diamond disk (100 μm) was used, which minimizes loss of material during procedures[11].In order to avoid heat development, besides the irrigation from the handpiece a continuous water jet was applied directly on the section and the lowest possible rotation speed of the handpiece was used[7,11-15].

Passive Ultrasonic Irrigation (PUI) was applied after chemical and mechanical preparations of the canal so as to improve cleanliness levels of the areas that could not be reached by endodontic instruments. It is important to point out that this may enable cleaning oval-shaped areas and the subsequent filling with the filling materials being studied[15,16].

As to the experimental design of this research, the TC® System showed that gutta-percha had a better filling quality.Such results are consistent with studies undertaken by Ribeiro *et al*.[11], Pereira *et al*.[6] and Piati *et al*.[7].Filling of this system seems to be related with the type of gutta-percha being used, the "Alpha" form.This type of gutta-percha has different features that enable this performance, such as viscosity, fluidity and better adhesion[10]. According to Ribeiro et al.[11], the aim of obturation is total filling, with a homogeneous mass of gutta-percha and a perfect adaptation to the canal walls by techniques that reduce the endodontic sealer and void spaces.Hence, under the conditions of this research, the TC® System seems to have shown a very good performance in this regard.

Tagger's Hybrid and Touch'n Heat® techniques showed similar filling values in the obturation materials, but also showed statistical differences when compared to the TC® System.Namely in the apical third, there was a higher amount of endodontic sealer in the TH and TG techniques.In this research, the lower filling ability of gutta-percha in the apical third may be due to the fact that this material has not undergone any plasticizing process in this area, as the devices used do not reach the apical area.On the other hand, the TC® System introduces already plasticized gutta-percha throughout all the root canal. It is recommended that gutta-percha solid cones be used only in rounded canals, because, when used in irregular-shaped canals, it results in void areas or in large volumes of endodontic sealer[17,18]. Due to solubility, to contraction and to lack of dimensional stability, only a thin layer of cement should be applied on the inner walls of root canals[19].

Even though it is recommended that a small amount of cement be added to the obturation mass, nowadays, endodontic sealers have undergone improvements in their properties, which in the past made their questionable properties to be used in filling large areas of root canal, especially in oval-shaped areas where, as described above, solid gutta-percha is not an effective material.This is the case of the Ah Plus® sealer, used in this experiment. This sealer presented adequate standards of radiopacity, solubility, flow, adhesion and setting time when it was tested according to the requirements of the American Dental Association (ADA).[20]

Void areas were scarce and there were no statistical differences between the techniques.This showed that the main purpose of obturation, the sealing of all the root canal, was obtained with all the techniques under study[21,22].

Even if filling materials have offered good filling levels in all these techniques, endodontic sealer must be selected having a good knowledge of its properties as this sealer cannot go through contractions and cannot be solubilized in the root canal, especially in irregular-shaped canals.

Even though the TC® System has been unanimously considered as the most satisfactory filling (with plasticized gutta-percha being used for filling root canals), other studies are still needed for evaluating its performance in terms of technical skill, risk of over-obturation and possible root heating, as there are very few studies available concerning its use.

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