

Effectiveness of Rotary or Manual Techniques for Removing a 6-Year-Old Filling Material

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The aim of this study was to evaluate the effectiveness of manual and rotary instrumentation techniques for removing root fillings after different storage times. Twenty-four canals from palatal roots of human maxillary molars were instrumented and filled with gutta-percha and zinc-oxide eugenol-based sealer (Endofill), and were stored in saline for 6 years. Non-aged control specimens were treated in the same manner and stored for 1 week. All canals were retreated using hand files or ProTaper Universal NiTi rotary system. Radiographs were taken to determine the amount of remaining material in the canals. The roots were vertically split, the halves were examined with a clinical microscope and the obtained images were digitized. The images were evaluated with AutoCAD software and the percentage of residual material was calculated. Data were analyzed with two-way ANOVA and Tukey's test at 5% significance level. There was no statistically significant differences ($p > 0.05$) between the manual and rotary techniques for filling material removal regardless the ageing effect on endodontic sealers. When only the age of the filling material was analyzed microscopically, non-aged fillings that remained on the middle third of the canals presented a higher percentage of material remaining ($p < 0.05$) compared to the aged sealers and to the other thirds of the roots. The apical third showed a higher percentage of residual filling material in both radiographic and microscopic analysis when compared to the other root thirds. In conclusion, all canals presented residual filling material after endodontic retreatment procedures. Microscopic analysis was more effective than radiographs for detection of residual filling material.

Key Words: Endodontics, retreatment, gutta-percha.

INTRODUCTION

Non-surgical endodontic retreatment is indicated when there is persistence of a disease resulting from incomplete cleaning and shaping, microleakage, technical shortcomings, or complex anatomy (1). Among several treatment alternatives, non-surgical retreatment should be considered as the first choice (2). The main goal of retreatment is to regain access to the apical foramen by complete removal of the root canal filling material, thereby achieving sufficient cleaning and shaping of the root canal system and final proper obturation (3).

Different filling materials have been tested for the

efficacy of retreatment techniques by different methods, including radiography (4-6), clearing (6-8), projection of photograph onto a screen (1,2,9), stereomicroscopy (2,4,10-13), scanning electron microscopy (1,14-16), evaluation of digitized images using a scanner (3), micro-computed tomography (17) and computed tomography (13).

Removal of obturation material can be effected with endodontic hand files, heat-carrying or ultrasonic instruments, or engine driven rotary files (10). Several techniques using manual or rotary protocols with or without solvents have also been suggested to remove the filling material from root canals (1,16). However,

there are no studies testing the influence of the age of the filling material on the capacity for filler removal.

The aim of this study was to evaluate the effectiveness of manual and rotary techniques for removing 6-year-old filling material compared to non-aged sealer through radiographic and microscopic analyses.

MATERIAL AND METHODS

The study protocol was approved by the University of Passo Fundo's Research Ethics Committee (Process #0019.0.398.000-08).

Forty-eight palatal roots of extracted human maxillary molars were used. Initially, 24 root canals were negotiated with a size K-15 file (Dentsply/Maillefer, Ballaigues, Switzerland) until its tip was visible at the apical foramen, and the working length (WL) was established 1 mm short of canal length (15 mm). The root canals were instrumented using a crown-down technique that was up to 2 file sizes greater than the initial one with respect to root canal anatomy using 1 mL irrigation with 1% sodium hypochlorite (NaOCl) (Farmácia Calêndula, Porto Alegre, RS, Brazil) between each file. The smear layer was removed with 5 mL of EDTA (Farmácia Calêndula), followed by 5 mL of 1% NaOCl as the final irrigation. The root canals were dried and filled with a zinc oxide-eugenol-based sealer (Endofill; Dentsply Ind. e Com. Ltda., Petrópolis, RJ, Brazil) and gutta-percha (Tanari; Manucaparu, AM, Brazil) using a cold lateral condensation technique.

Accesses were temporized with Cavit (3M/ESPE, St. Paul, MN, USA) and the roots were embedded in gauze containing saline solution, which was renewed every 2 weeks, and were kept at room temperature for 6 years. All procedures were repeated with the 24 control roots that were maintained in the previously described conditions for 1 week.

Retreatment Techniques

All root canals had 3 mm of filling material removed from the cervical portion of the canal using Gates Glidden burs #3 and #4 to create a reservoir for the solvent. A drop of solvent (Eucaliptol; Inodon-Ltda, Porto Alegre, RS, Brazil) was delivered into each canal and a size 20 K-file (Dentsply/Maillefer) was forced in the apical direction to soften the filling material. All specimens were then randomly divided into 4 groups:

Group 1 (n=12): Gutta-percha and aged Endofill

were removed with the sequential use of sizes 20 to 30 hand K-files until no more gutta-percha/sealer could be seen on the last file used and the canal walls were smooth. Then, a crown-down technique was performed up to 2 file sizes greater than the prior instrument according to the anatomical variations of the roots.

Group 2 (n=12): Gutta-percha and aged Endofill were removed with ProTaper Universal NiTi rotary files (Dentsply/Maillefer). The filling material was initially removed with a paintbrush motion with files S1 and SX reaching the cervical third and file S2 for the middle third of the canal. Thus, the working length was regained gradually from file F1 to F4. The files were attached to a handpiece activated by an electric motor at 350 rpm and 3.0 N/cm torque.

Groups 3 (n=12) and 4 (n=12): Gutta-percha and non-aged Endofill were removed using the same techniques described for group 1 and 2, respectively.

Each rotary or hand instrument was discarded after being used in 5 canals and a single operator prepared all specimens. During the retreatment process, root canals were constantly irrigated with 1% NaOCl followed by a final irrigation using 17% EDTA. All roots were dried and radiographs were taken and processed using a time-temperature method for further analysis. The radiographs were imaged with a digital camera (Nikon-Colpix 4500, Tokyo, Japan).

All roots were vertically grooved with steel discs on both buccal and lingual surfaces, avoiding reach the root canal space. The roots were split into halves and the percentage of residual filling material was observed with a clinical microscope (DF Vasconcellos, São Paulo, SP, Brazil). Microscopic images were acquired with a digital camera (Nikon-Colpix 4500) and the percentage of residual filling material was measured using AutoCAD 2004 software (Mechanical Desktop Power Pack; Microsoft, Redmond, WA, USA). After digitization, microscopic and radiographic images were processed in the AutoCAD software. One of its tools allowed a more uniform observation of the root canal thirds.

The filling debris area/third canal area ratios were considered for statistical analysis by two-way ANOVA and Tukey's test at 5% significance level, and were expressed as percentage of filling material left after reparation.

RESULTS

Table 1 presents the percentage of remaining

debris in the different thirds root canal (cervical, middle and apical) for the different groups, after microscopic and radiographic analysis.

Microscopic analysis demonstrated no statistically significant differences ($p > 0.05$) between manual and rotary techniques for filling material removal, independently of the age of the filling material. However, when only the age of the filling material was tested, non-aged fillings that remained on the middle thirds presented a significantly higher percentage of material ($p < 0.05$) compared to the aged sealers and to the other thirds of the roots. Radiographic analysis showed no statistically significant differences ($p > 0.05$) for any criteria between the experimental groups.

When root thirds were analyzed separately, independently of the retreatment technique and the filling material age, the apical third showed higher percentages of residual filling material ($p < 0.05$) compared to the other thirds in both radiographic and microscopic analyses.

In addition, microscopic analysis detected a significantly higher percentage of residual filling material than radiograph (Student's t-test, $p < 0.05$).

DISCUSSION

Despite being a difficult and time-consuming procedure, endodontic retreatment is undoubtedly the first choice for the management of endodontic failures when access to the root canal is possible. Removing the old filling material is important to reach the remnants of necrotic pulp or bacteria that may be responsible for the periapical infection (17).

In this study, the methods under investigation

were standardized and performed by the same operator to eliminate operator-dependent failures. The use of Ni-Ti rotary files activated by a 350-rpm low-speed electric motor with low torque was established according to the manufacturer's protocol. These conditions contribute to increase tactile sensation, avoiding file separation (2).

The choice of using a solvent in this study considered the existing literature (1,2,7,9,10,18) and the clinical relevance as it attempted to mimic genuine clinical situations that demand solvation. Some studies reported favorable results with the use of solvents to remove gutta-percha (17,19).

This study evaluated digital images from periapical radiographs and post-cleavage exposed root canal photographs. Radiographic images were chosen because radiography is the most common clinical method to evaluate the remaining filling material during endodontic retreatment (4-6). However, this technique produces only a two-dimensional view of three-dimensional structures. However, recent investigations (4,5,20) have reported the applicability of the AutoCAD 2004 software to calculate the percentage of remaining filling material. This experiment denoted the superiority of the microscopic method over the radiography to determine percentage of remaining filling material.

In agreement with previous studies (5,9), the present results did not show significant differences between the retreatment techniques, independent of the filling age and the instrumented area. Conversely, other investigations have found that the rotary instruments provided cleaner dentin walls when compared to manual techniques (3,11). Hullsman and Blum (2) found a lower percentage of filling material in the middle and

Table 1. Percentage remaining debris in the different thirds (cervical, middle and apical) for both retreatment techniques (hand files *versus* ProTaper) as determined by the microscopic and radiographic analyses.

Canal third	Microscopic analysis				Radiographic analysis			
	Hand file		ProTaper		Hand file		ProTaper	
	Non-aged sealer	Aged sealer	Non-aged sealer	Aged sealer	Non-aged sealer	Aged sealer	Non-aged sealer	Aged sealer
Apical	17.12 ^{abA}	12.21 ^{abA}	4.67 ^{abA}	21.61 ^{abA}	9.44 ^A	9.32 ^A	3.42 ^A	12.30 ^A
Middle	5.36 ^{aaB}	0.50 ^{abB}	6.69 ^{aaB}	0.51 ^{abB}	0 ^B	0.17 ^B	0.52 ^B	0 ^B
Cervical	0.18 ^{abB}	0 ^{abB}	0.53 ^{abB}	0.07 ^{abB}	0 ^B	0 ^B	0.42 ^B	0 ^B

Two-way ANOVA and Tukey's test; $p < 0.05$. The first lowercase letter compares differences between the manual and rotary techniques, independently of the age of the filling material. The second lowercase letter compares the age of the filling material, in the different root canal thirds. The uppercase letter compares the different root canal thirds, independently of the technique and the filling material age, in both radiographic and microscopic analyses.

cervical thirds when using the ProTaper and Flexmaster files compared to the hand instrumentation.

Clinical practice has shown that endodontic retreatment may be necessary several years after the initial root canal therapy is performed. Therefore, the age of the filling material may be a relevant factor for consideration in root canal retreatment. Furthermore, there are no consistent data available on this topic. The present study demonstrated a higher percentage of a non-aged filling material in the middle third of the roots when compared to the aged one. A hypothetical explanation is the time length of filler presence, since the non-aged filling material presents a better bond between the sealer and gutta-percha and a higher adhesion to dentin walls.

The results of the study propose the following question: why was not there difference between non-aged and aged sealer in apical and cervical thirds? It is known that canal cross-section tends to be more circular as nearest to the apical third, benefiting instruments action onto canal walls. In the cervical third of the root, straight line access facilitates the removal of old filling material. When working with hand files, the action can be directed to the flattened areas (9). Although the Shaping files of the ProTaper system allow for paintbrush movement (according to the manufacture instructions), the effect is not the same as with hand instrumentation. It should also be considered that hand files can be pre-curved and directed to the regions in which the tactile sensation indicates the presence of filling material (20).

When comparing the root canal thirds separately, a higher percentage of filling material was found in the apical third. This is consistent with the findings of other studies (4,5,15,19) and was observed in both radiographic and microscopic analysis of samples. The apical third is a critical zone, requiring a considerable enlargement when cleaning and shaping the canals (20). This procedure can lead to apical deviations that might be responsible for maintenance of filling material in the canal during retreatment.

In conclusion, both retreatment techniques left filling debris in the root canals, regardless of the filling material age. The apical third a higher percentage of residual material. Microscopic analysis was more effective than radiography to detect filling debris after the retreatment procedures.

RESUMO

Objetivo deste estudo foi avaliar a efetividade da instrumentação

manual e rotatória na remoção de material obturador de canais radiculares de raízes palatinas de molares superiores humanos, em dois períodos de tempo. Vinte e quatro raízes foram instrumentadas e obturadas com gutta-percha, cimento de óxido de zinco e eugenol e armazenadas em solução salina durante 6 anos. Outras 24 raízes foram tratadas da mesma maneira e armazenadas por uma semana. Os canais radiculares foram retratados usando limas manuais ou instrumentos rotatórios do Sistema ProTaper Universal. Radiografias periapicais foram feitas para mensurar a quantidade de material remanescente. Posteriormente as raízes foram clivadas e imagens microscópicas obtidas a partir de um microscópio clínico operatório foram digitalizadas. As imagens foram avaliadas através do software Autocad 2004 e área de material obturador remanescente foi mensurada. A Análise da Variância (Two-way) e o Teste T demonstraram não haver diferenças estatisticamente significantes entre a técnica manual e rotatória na remoção de material obturador. O terço apical mostrou a maior percentagem de remanescentes de material obturador, na análise radiográfica e microscópica quando comparado com os outros terços radiculares. Todos os canais revelaram resíduos de material obturador após o retratamento endodôntico. A análise microscópica foi mais efetiva do que a radiográfica na detecção de remanescente de obturação do canal radicular.

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Accepted March 17, 2010