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## The performance of ProTaper system during the endodontic retreatment

### *A performance* do Sistema ProTaper no retratamento endodôntico

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#### **Abstract**

The development of new rotary instruments for endodontic treatment demands new studies to evaluate their efficacy on the retreatment of root canals. The scope of this study was to analyze the partial or total removal of the filling material by the ProTaper system in the retreatment of gutta-percha-filled root canals, as well as the time required to reach the previous working length. Thirty-six human canines were equally divided in three groups (n= 12) and had their root canals prepared by the following methods: GI= Thermafill system; GII= McSpadden; GIII= lateral condensation. After that, all specimens were retreated without solvent and using the ProTaper system. The time necessary to remove the filling material was registered. After the removal of the filling material, the specimens were sectioned longitudinally and magnified images of the sections were recorded and printed. The presence or absence of remaining filling material was registered. The results showed a significant statistical difference between the McSpadden group and the others with relation to the time required for filling removal. All groups exhibited an

*Palavras-chave:*  
retratamento endodôntico;  
ProTaper; gutta-percha.

incomplete removal of the filling material. It can be concluded that although the rapidity that the ProTaper instruments reached the working length, the system has to be associated to another retreatment.

## Resumo

O desenvolvimento de novos instrumentos rotatórios para o tratamento endodôntico gera a necessidade de novos estudos para avaliar a eficiência desses instrumentos no retratamento dos canais radiculares. Este trabalho buscou avaliar se a remoção do material obturador é total ou parcial, bem como o tempo gasto para atingir o comprimento de trabalho utilizando-se o sistema ProTaper. Trinta e seis caninos humanos foram preparados e obturados formando três grupos experimentais (n= 12): GI = sistema Thermafill; GII = McSpadden; GIII = condensação lateral. Os três grupos foram então submetidos ao retratamento utilizando-se o sistema ProTaper (sem o uso de solvente) e os tempos foram aferidos. Após a remoção do material obturador, os espécimes foram seccionados longitudinalmente e avaliados por meio de uma câmera acoplada a uma impressora, para determinação da presença ou não de remanescente obturador. Como resultado, obteve-se uma remoção incompleta do material obturador de todos os espécimes, e com relação ao tempo houve diferença estatisticamente significativa entre o grupo obturado com McSpadden e os demais grupos. Conclui-se que os instrumentos ProTaper testados mostraram-se rápidos para atingir o comprimento de trabalho durante o retratamento, entretanto devem ser complementados por outra técnica de retratamento.

## Introduction

The major importance of the retreatment of dental root canals relies on its potential to revert failed endodontic treatments. The primary purposes of the retreatment therapy are the adequate cleaning and disinfection of the root canal system. However, steps of varied difficulties constitute a barrier to achieve these objectives, for instance: the complete removal of the filling materials, the re-shaping of the root canal, the dislodgement of the smear layer and smear plug, and the filling of the root canal with a temporary filler (i.e. calcium hydroxide). Anatomical complexities inherent to each particular teeth category and technical limitations of the chosen retreatment method have a direct effect on the aforementioned steps.

An alternative method that uses nickel titanium rotary instruments has been shown to be promising. An important aspect of this method is the possibility to remove the intra-canal fillers without using gutta-percha solvents [1, 3]. Thereby, the formation of a thin film of gutta-percha on the walls of the root canal [4] could be avoided by depleting the use of solvents. Such film might reduce the action of the intra-canal

medicaments and the adhesion of the intra-canal sealer to the root canal walls on the retreatment therapy. Other advantages of the method are the non-use of potential carcinogenic products [5] and the elimination of possible apical extrusion of gutta-percha by the excessive dissolution of this material.

The use of rotary instruments for the retreatment of root canals has been investigated. Some examples are the Quantec SC (Sybron-Kerr) [2] and the ProFile (Dentsply-Maillefer, Ballaigues, Switzerland), with the latter being notably investigated in the literature [1, 3, 6, 7]. A new rotary system ProTaper (Dentsply Maillefer, Ballaigues, Switzerland) introduced in the market features a convex triangular cross-section, which reduces the contact area between file and dentin, and a patented progressive taper design, responding for an improved flexibility and cutting efficiency. Other advantages of the system include the reduced number of instruments plus the simplicity and speediness of the method.

The aim of this study was to investigate the partial or total removal of filling material, as well as the time required to reach the previous working length, in root canals previously treated with three endodontic systems and retreated using the ProTaper system.

## Materials and methods

A total of 36 single-rooted lower human canine teeth with straight canals and average length of 25 mm were used. After being cleaned and sterilized in autoclave, all teeth were stored in distilled water until the beginning of the experiment. When the obturation procedures started, all teeth were stored wet in order to avoid desiccation.

Root canals were prepared using the principle of step-down technique [8]. The cervical and the middle-thirds were prepared with sizes 1-3 Gates Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland) in a telescopic preparation at every 2 mm. The apical third was prepared using Nitiflex files (Dentsply Maillefer, Ballaigues, Switzerland) with an automated device 3 LD head and 3624 angular piece (Kavo, Bilberach, Germany), which had a reciprocating action of 90°. The master apical file was size 30 and one individual performed all preparations.

After preparation, the specimens were obturated using three different techniques:

- 1 – Group I: Thermafil System Technique – Thermafil obturators size 30 (Dentsply Maillefer, Ballaigues, Switzerland);
- 2 – Group II: Thermomechanical compaction technique (Gutta Compactors, Dentsply Maillefer, Ballaigues, Switzerland, and gutta-percha cones size 30, Tanari, Tanariman, Manacapuru, Brazil); and
- 3 – Group III: lateral condensation technique (gutta-percha cones size 30, Tanari, Tanariman, Manacapuru, Brazil).

### Thermafil (group I)

In the Thermafil technique (group I), a size 30-verifier was placed in the root canal to the working length. This length was then transferred to a Thermafil carrier. After drying the canal, Sealer 26 (Dentsply, Petropolis, Brazil) was applied to the walls and the obturator was heated and then inserted into the canal to the working length. The carrier was cut at the canal orifice using a diamond bur number 1014 (KG Sorensen, Barueri, Brazil). A radiographic was taken with the X-ray cone positioned perpendicular to the tooth in the buccolingual direction.

### Thermomechanical compaction (group II)

After selection of the master cone and the Gutta Compactor of the same size, Sealer 26 was applied to the root canal walls. The master cone (size 30, Tanari, Tanariman, Manacapuru, Brazil) was cemented at the working length, and space created with a finger

spreader. The compactor was introduced and then activated until the heat caused by the friction of the compactor with the root dentine softened the gutta-percha. The compactor was removed and the gutta-percha was compacted vertically using a size 1 vertical plugger. Excess material was removed with a heated vertical plugger. A radiograph was then taken as previously described.

### Lateral Condensation (group III)

After the application of the sealer to the canal walls and cementation of a size 30 master cone, space was created with a spreader, and accessory cones were inserted until the canal was full. Excess material was removed with a heated vertical plugger and radiographs were again taken as previously described.

### Removal of fillings with the ProTaper system

All teeth were stored in a 100%-humidity recipient at room temperature. Two weeks later, the filling of all specimens was removed using the ProTaper system (Dentsply-Maillefer, Ballaigues, Switzerland). A ProTaper SX instrument at the maximum length of 19 mm and F1 instrument were used at a speed of 300 rpm with an air-operated motor 67CN head and 3630 reducing hand piece (Kavo, Bilberach, Germany) in a crown-down manner to the previously established working length. The time required to reach the working length was recorded. After registering the time, the root canals were instrumented with the F1 instrument. Radiographs were taken in the buccolingual direction with the X-ray cone positioned perpendicular to the tooth. One single operator conducted all endodontic treatment and retreatment procedures.

After removing the filling material, the teeth were grooved longitudinally with carborundum disks and split with a chisel. A hyper color video camera (10 x) (Sony, Tokyo, Japan) connected to a color video printer (Mavigraph 1B 1200 A, Sony) recorded and then printed images from the cut specimens. This equipment also amplified the images to analyze the absence or presence of filling material in each group. Two examiners, who were unaware of the origin of the experimental groups, recorded the filling removal of the root in terms of the absence or presence of filling material. They also sought to identify Thermafil plastic carrier (group I) because the literature refers to the difficulty in removing carriers of this system.

The time required to reach the working length was recorded and submitted to statistical analysis (ANOVA and Tukey's test).

## Results

The previously determined working length was reached in all specimens. The visual and radiographic identification of the remaining filling material on the longitudinal sections allowed observing the following parameters in the specimens:

- Incomplete removal of the filling material in all specimens;
- Although the removal of gutta-percha was incomplete, ProTaper F1 reached the working length in all specimens;
- The removal of Thermafil plastic carriers was incomplete in all specimens of this group.

Table 1 shows the time required for achieving the working length with the instruments ProTaper Shaping X and Finishing 1.

Statistical analysis showed a significant statistical difference ( $p < 0.05$ ) between group II and the other groups. No significant statistical differences ( $p > 0.05$ ) were detected between group I and III.

are the previous shaping of the teeth and the great anatomical dimensions of the canines on the middle and cervical thirds.

Baratto Filho *et al.* (2002) [3] achieved a better displacement of the filling material using the Profile .04 system. Although only three specimens were entirely cleaned, promising results were observed at the middle third level, where just 10% of the specimens showed residues. Additionally, the removal of Thermafil plastic carriers was complete in all specimens. The ProTaper instruments investigated in this study are smaller than those of the ProFile .04 system tested by Baratto Filho *et al.* [3], which could explain different performances in these studies. For instance, the greatest initial diameter (D0) of the ProTaper instruments is .30 mm (Finishing File 3).

Sae-Lim *et al.* (2000) [1] compared the ProFile system to the conventional technique using manual files, with chloroform being used in both techniques, for endodontic retreatment. The authors highlighted that the complete removal of the filling material is almost impossible. Also, the ProFile system was the most efficient in removing the filling material, with the best results found at the middle and apical thirds. The authors stated that the system is a practical alternative for endodontic retreatment. Barrieshi *et al.* (1995) [6] and Zuolo *et al.* (1996) [7] did not find significant differences in cleaning quality at different thirds of the root canal using the ProFile system associated with solvent.

Baratto Filho (2002) obtained considerably superior times than those of this study (Thermafill, 5 min. 24 s; McSpadden, 3 min. 11 s; Lateral condensation, 4 min. 37 s). However, these authors used a higher number of instruments and reported the time required for the whole retreatment procedure, and not only to reach the working length. In this study, group I (25,83 seconds) and group III (25,41 seconds) showed statistical similar times of filling removal. However, these two groups differed from group II (37,91 seconds), which achieved the higher filling removal time ( $p < .05$ ). The lesser time required for group I and group III might be related to the lower resistance against penetration of the instruments. Both plastic carriers and gutta-percha cones, respectively particular to Thermafil system and lateral condensation technique, appear to work as a guide to the step-down progression of the ProTaper files through the root canal. Oppositely, the presence of a more compact gutta-percha mass in the thermo mechanical compaction technique offered a

Table I – Time (sec.) required for removing the filling material

<b>GI= Thermafil</b>	<b>GII= Thermomechanical compaction (McSpadden)</b>
30	35
32	35
18	28
24	33
18	29
19	30
23	32
39	15
28	32
35	32
22	72
22	82
<b>Mean</b>	
25.83	37.92

## Discussion

According to the amount of filling material removed, the graphic and digital image analysis revealed that the rotary instruments appear to open a pathway through the filling material without displacing it considerably. Because the manufacturer recommends a simplified technique, hence dispensing the use of instruments to enlarge the middle and cervical thirds (Shaping 1 and Shaping 2), only Shaping File X and Finishing File 1 were used. Other reasons for using a simple technique

superior resistance to instrument progression. However, the three retreatment groups investigated in this study required less time compared to the ProFile .04 instruments in the investigation of Baratto Filho *et al.* (2002) [3], even with the methodological similarities between the two studies.

Barrieshi *et al.* (1995) [6] detected that the use of the ProFile system combined to a solvent in endodontic retreatment demanded a great time to remove the filling materials. However, these authors reported the time required for the whole retreatment procedure and not only to reach the working length, as considered in this study.

Bramante and Betti (2000) [2] investigated the Quantec SC instruments (numbers 5 to 10) and found working times as short as those found in this study only when employing high rotary speeds (33.4 seconds at 1500 rpm, and 95 seconds at 700 rpm). Differences between the ProFile and Quantec SC systems must be pointed out. The former has a series of instruments with an identical tapering shape, while the latter is a progressive taper system. Also, both systems have modified cross sections, with the ProFile system showing a “U-form” section with three cutting blades and the Quantec SC showing an asymmetric-shape cross-section with two cutting blades [9]. Such design strengthens the instrument by concentrating a greater amount of nickel-titanium alloy at the central portion of the instrument. Additionally, both instruments have a radial land, which keeps the instrument at its original central path and reduces cutting capacity by offering a negative cutting angle, particularly for the ProFile system. The Quantec SC shows a slightly positive cutting angle.

The diameter of the instrument at its initial laminar section (D0) is another important feature. For the ProFile system, the instruments show progressive diameters, which respond for considerably large instruments. Contrarily, such feature is not seen in Quantec SC instruments numbered from 4 to 8, which have D0 values fixed and equal to 0.25 mm. The multitapering of the Quantec SC instruments (“taper” 03 mm/mm to 06 mm/mm) does not confer the same largeness observed in the ProFile instruments. The Quantec SC instruments also show a faceted and cutting penetration guide, while the ProFile ones have rounded and inactive guides.

Obviously the physical differences here described play a role in the endodontic retreatment. Moreover, for this particular treatment, the ProFile manufacturer suggests an increase in the rotational speed (rpm), which has been previously evaluated [1, 2].

The considerations about the design of the rotary instruments in endodontic retreatment conducted in

this study and others previously published emphasizes the importance of the largeness of the instrument and its initial diameter on the success of such procedure.

## Conclusion

Although the rapidity of the ProTaper instruments in reaching the working length, a properly emptying and cleaning of the root canal was not achieved. The influence of rounder and smaller teeth on the efficiency of the ProTaper system in endodontic retreatment, as well of different rotary speeds, demand further studies.

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