Comparison of debris extruded apically and working time used by ProTaper Universal rotary and ProTaper retreatment system during gutta-percha removal

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ABSTRACT

Objective: The aim of this study was to evaluate the *in vitro* action of ProTaper retreatment files and ProTaper Universal in the retreatment of mandibular premolars. Material and methods: The amount of debris extruded apically was measured and the time to reach the working length and to complete the removal of gutta-percha was observed. Thirty teeth had their canals prepared using ProTaper Universal files and were obturated by the single cone technique. The teeth were then stored at 37ºC in a humid environment for 7 days. During the use of the rotary instruments for root canal filling removal, the apical portions of the teeth were attached to the open end of a resin tube to collect the apically extruded debris. Results: ProTaper Universal files were significantly faster (p=0.0011) than the ProTaper retreatment files to perform gutta-percha removal, but no significant difference was found between the files regarding the time to reach the working length or the amount of apical extrusion. Conclusions: ProTaper Universal rotary had better results for endodontic retreatment, and both techniques promote similar apical extrusion of debris.

Key words: Endodontics. Gutta-percha. Root canal obturation. Root canal therapy.

INTRODUCTION

The main goal of nonsurgical root canal retreatment endodontic therapy is to achieve the decontamination of the root canal system in order to establish healthy periapical tissues and allow tissue repair. Thus, nonsurgical retreatment aims to remove completely the root filling, to enable effective cleaning, shaping and filling of the root canal system[23]. Many techniques have been employed for the removal of gutta-percha (GP) in root-filled teeth. These include endodontic hand files combined with heat or chemical solvents[7,19], engine-driven rotary files[9], ultrasonic instruments, heat-carrying instruments and lasers[18]. Removal of GP using hand files with or without solvents is time-consuming[10,20,22,26]. The use of NiTi rotary instruments has already been proven efficient and time-saving for the removal of GP[11,14].

When endodontic retreatment is performed, irritants in the form of filling materials, necrotic pulp tissues, bacteria, or irrigants might be introduced into the apical lesion. Apical extrusion of debris produced in endodontic treatment and retreatment might lead to postoperative pain and discomfort[22]. These apically extruded materials have been held clinically responsible for postoperative inflammation and flare-up or even failure of apical healing[16,25]. However, the amount of debris extruded apically might vary according to the technique used. Although there is considerable evidence that almost all instrumentation techniques promote apical extrusion of debris to some degree[3,12-14,24], a common finding is that techniques involving a push-pull motion usually create a greater mass of debris than those involving some sort of rotational crown-down action[2,10,15,17]. Therefore, an appropriate retreatment technique should be

selected to remove the preexisting filling material as fast and as complete as possible while minimizing the amount of apical extrusion.

ProTaper Universal NiTi rotary instruments present variations in taper along the file length, thus allowing creation of two different instruments in one, presenting tapers ranging from 2 to 19% in the same instrument[5], apart from shaping and finishing files, contains a retreatment system, which is designed for root filling removal in case of retreatment. The aim of this investigation was to compare the retreatment action of rotary systems originally designed for primary treatment (ProTaper Universal) and systems specifically designed for retreatment (ProTaper retreatment files) in relation to the amount of debris extruded apically, and the time to reach the working length and to complete the removal of the root filling material.

MATERIAL AND METHODS

Thirty straight premolars with single oval roots were selected for this study.

All teeth were accessed and cervical and middle third of the canals were flared using Gates-Glidden drills #1, 2 and 3 (Dentsply Maillefer, Ballaigues, Orbe, Switzerland) in a crown-down technique. Then a #8 K-file (Dentsply Maillefer) was inserted 1 mm beyond the point at which it was first visible to confirm apical patency and the presence of only one canal. Working length (WL) was established 1 mm short of the length at which a size 15 K-file was visualized at the apical foramen. The mean value for the WL of the teeth was 22 (±1.52) mm. ProTaper Universal was then used in the following sequence: SX, S1, S2, F1, F2 and F3. During instrumentation, 5 mL of sodium hypochlorite was used between each instrument. The obturation was performed using a single master cone F3 (Dentsply Maillefer) and N-Rickert sealer (Formula & Ação, São Paulo, SP, Brazil). All teeth were stored at 37ºC in a humid environment for 7 days to allow complete setting of the sealer.

Thirty resin tubes were made for collection of apically extruded debris, according Araquam, Britto and Nabeshima[4] (2009). These tubes were weighed to 10^{-4} precision by using a microbalance (Sartorius AG, Göettingen, Niedersachsen, Deutschland). Three consecutive measurements were taken for each tube, and the mean value was recorded. All teeth were coded and then randomly assigned to 2 groups of 15 specimens each. Then, the open end of each tooth was attached to the apical portion of each tooth[4] and retreatment was performed.

In Group 1, ProTaper Universal shaping and finishing files (Dentsply Maillefer, Ballaigues, Orbe, Switzerland) were used for retreatment. GP was removed by introducing the SX file and then S1, S2 and F3, in this sequence, were used to remove the GP until the WL was reached. In Group 2, GP was removed with ProTaper Universal retreatment system (Dentsply Maillefer, Ballaigues, Orbe, Switzerland) following the manufacturer's instructions. D1, D2, and D3 were sequentially used at 500 rpm until the pre-established WL was reached. During all retreatment procedure, flutes of the files were cleaned with sodium hypochlorite after each use.

Apical extrusion of debris was measured by weighing the tube after the retreatment procedures and subtracting the values from the initial weight. Once again, three consecutives measurements were taken and the mean value was recorded. In no case was the resin tube touched with fingers.

GP removal was judged complete when the WL was reached and no more GP could be seen on the last instrument used in each group. The time to reach the WL and the time needed to complete GP removal were recorded to the nearest second, from the start of GP removal to the point where WL was reached and retreatment was considered complete, respectively.

The mean time to reach the WL and to remove GP, and the weight of apically extruded debris were analyzed statistically by Mann-Whitney U test at 5% level of significance.

RESULTS

In Group 1, the mean time to reach the WL using ProTaper universal files was shorter (55.20±13.84 s) than in Group 2, using ProTaper retreatment files, (63.73±11.23 s), but the groups did not differ significantly (p=0.0712). However, GP removal was significantly faster in Group 1 (146.47±22.32 s) than in Group 2 (181.93±24.80 s) that it showed significant difference (p=0.0011).

All retreatment techniques used in this study caused extrusion of apical debris. The mean weight ± standard deviation of apically extruded debris in grams caused by each of the retreatment techniques was as follows: ProTaper Universal: 0.0294±0.0155; ProTaper retreatment files: 0.0311±0.0306. No statistically significant difference was observed in the amount of apically extruded debris between Groups 1 and 2 (p=0.7244).

There were three fractured instruments: two SX files in Group 1 and one D3 file in Group 2.

DISCUSSION

The reason for a negative outcome following root canal treatment is usually the persistence of bacteria, which may resist to conventional endodontic therapy due to characteristics of contamination and also due to the presence of areas

that cannot be reached by the instrument. Thus, the goal of root canal filling removal in Endodontics is to remove as much sealer and GP as possible in order to uncover remnants of necrotic tissues or bacteria that might be responsible for persistent periapical inflammation[18,23]. To achieve these objectives, the use of files with or without chemical solvents is the most frequent option[6,10,17,20,22,26]. Recently, several studies have shown that NiTi rotary instruments using a variety of techniques are effective in remove filing materials from root canals[2,11-14,20,25]. This may be due to the fact that the rotary movements of engine-driven files produce a certain degree of frictional heat which might plasticize GP. The plasticized GP would thus present less resistance and be easier to remove[6]. Also, rotary instruments have been proven less time-consuming than hand files[14,22], although they have sometimes been found less effective in cleaning the canal walls[11].

In the present study, ProTaper Universal rotary instruments (Group 1) were faster to reach the WL and to perform the GP removal than ProTaper Universal retreatment instruments (Group 2). It was observed that initial penetration of Group 2 instruments was easier compared to Group 1 instruments due to the active tip of the instrument D1. On the other hand, D2 and D3 files are shorter than S1, S2 and F3 files and so they took significantly more time to reach the WL and to completely remove GP. Also, the specific flute design of ProTaper instruments associated with their rotary motion tends to pull GP into the file flutes and direct it towards the orifice. Furthermore, ProTaper instruments have progressive tapers and lengths, which enable them cutting not only GP but also the superficial layer of dentin during root filling removal. Moreover, they have more flexibility due to a shallow U-shaped groove at each of their convex triangular sides in cross section[1].

In this study, both groups presented apical extrusion of debris, and these results are consistent with other apical extrusion studies[20,24]. These findings reinforce the fact that it is impossible to prepare a root canal system chemomechanically without any extrusion of debris independent of the technique used[2,3,15,25]. Investigations measuring the amount of debris with the aid of microbalance might detect the tiny differences among various techniques[13], although, in this study, statistical difference was not observed between techniques. The results of the present study demonstrated that, with only few exceptions, the amount of apically extruded materials from each specimen was around 0.03 g, and significant differences were not found between the groups.

Prior to the introduction of ProTaper Universal retreatment files, ProTaper rotary finishing files had been used for GP removal[14]. This technique yielded a high-fracture incidence of 22.7%[20]. In this investigation, however, it could be observed in Group 1, only one plastic deformation in an F3 file and two fractures of SX files. Moreover, in Group 2, procedural errors including instrument fracture were observed in only one D3 instrument after it was used eleven times. These failures were probably due to the fact that these instruments are submitted to high stress concentrations in the beginning and in the end of the retreatment procedure.

When NiTi rotary instruments are used to remove GP, slight apical pressure has to be exerted for file penetration. If the rotary instruments fail to progress along the canal path, stainless steel hand files may be used to check the resistance and establish the glide path. Furthermore, files should be withdrawn frequently for the removal of the debris from instrument flutes before being reintroduced in the root canal system. In the present study, no perforations, blockages, or ledging were registered. Although earlier studies reported a higher risk of instrument fracture when using NiTi rotary files versus hand files[6,8,10,19,20,24,26], the results of the present study showed that the use of NiTi rotary files for retreatment of straight root canal fillings appeared to be safe, fast and effective in avoiding a significant amount of apical extrusion of debris.

CONCLUSION

ProTaper Universal files were faster than the ProTaper retreatment files to perform GP removal in the retreatment of teeth obturated according to the single master cone technique, and both techniques promoted similar apical extrusion of debris.

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