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ORIGINAL ARTICLE

Efficacy of Protaper Next Compared to Wave One in Intraradicular Dentin Wear in Flattened Root Canals

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Abstract

Objective: To compare the degree of intraradicular wear in flat channels with mechanized instrumentation. **Material and Methods:** A total of 48 dental units were selected of central and lateral lower incisors, divided into two groups of 24 units each according to the type of instrumentation system: G1 - Protaper Next Group; G2 -Wave One Group. Teeth were exposed to room temperature for seven days for drying. After this exposure, the initial weighing (P0) of the roots in analytical balance was carried out. After instrumentation, the specimens were again exposed at room temperature for another seven days and then the second weighing (P1) was performed. The difference found between the values attributed to the two weighings of each specimen represented the wear of the dentin walls in order to compare the degree of wear between the study groups. Statistical tests were performed for analysis of variance (ANOVA), using a significance level of 5%. **Results:** Comparison between rotational and reciprocating systems showed that reciprocating files significantly promoted ($p<0.05$) increased intraradicular dentin wear in relation to rotating files. **Conclusion:** The use of Wave One Reciprocating Files was considered more effective in the wear of flattened root canals, thus presenting better cleaning ability in the treatment of inflammatory and/or infectious canal processes.

Keywords: Endodontics; Root Canal Preparation; Root Canal Obturation.

Introduction

Mechanical preparation is an important step in endodontic treatment and consists of eliminating microorganisms and their by-products from the root canal system. However, the anatomical variability that characterizes the root canal makes it difficult or even impossible to completely disinfect the pulp cavity using instruments [1].

Endodontic therapy aims at the rehabilitation of the dental unit ensuring the elimination of inflammatory and/or infectious processes so as to allow an efficient sealing of the root canal system, and thus, increasing the desired success of the treatment [2]. This phase of preparing the root canal has undergone great transformation in recent years, in view of the gradual "replacement" of the manual preparation by the automation of the modeling techniques [3].

Among the available automation systems, there are rotary systems with continuous movement [4] and alternating reciprocating systems [5]. The rotary files were the most used in canal modeling due to their high cutting efficiency [6]; however, they presented some disadvantages such as: the use of several instruments, fracture risk, and cross contamination [7]. In view of these disadvantages, the alternating movement through the Protaper F2 file was proposed, using a simpler, more convenient and safer method to prepare the root canal [8].

The present study aims to evaluate the dentin wear caused by different automated instrumentation systems based on the weighing method.

Material and Methods

For the development of this study in vitro, 48 human lower central and lateral incisors were selected. The teeth had apex and complete root formation, without calcification and without any previous treatment and similar dimensions, diameter 4.0 to 5.0 mm in the mesiodistal direction and 5.0 to 6.5 mm in the vestibular-palatine direction. After rigorous cleaning, the dental units were randomly distributed, stored in plastic collection containers, placed in 0.1% thymol solution, and kept under refrigeration until use.

For the preparation of the specimens, horizontal sectioning of the crowns was done using a carborundum disc mounted on a mandrel adjusted to the straight part of the dental micromotor, respecting the 2 mm limit of the remainder of the coronal portion measured with the aid of a compass [9]. Thus, an average length of 16 mm of the dental roots that composed the specimens to be used in the laboratory experiments was obtained.

After the preparation of the specimens, the 48 lower incisors were separated into two groups, randomly composed of 24 elements each, namely: G1: Protaper Next (Dentsply Tulsa Dental, Oklahoma, USA) and G2: Wave One (Dentsply Maillefer Instruments SA, Ballaigues, Switzerland). Endodontic treatment was performed with the Protaper Next rotary system and the reciprocating system with Wave One files according to each group (Table 1).

- Group 1: Instrumentation with the Protaper Next System was performed with rotary files X1, X2, X3, and X4 in brush stroke associated with manual files. Initially, the root canals of the

specimens were explored with the K15 manual file, followed by instrumentation with the X1 and X2 files and completion of this procedure with the X3 and X4 rotary files. All canals were finished with the #40 manual file for refinement and irrigated with 5 mL of 2.5% sodium hypochlorite after application of each instrument.

- Group 2: Previously explored with the K15 file, the root canals were instrumented with the Wave One Large reciprocating file (40/08) with in-and-out movements. Likewise, the canals were refined with the #40 manual file and irrigated with 2.5% sodium hypochlorite at each advance in the third of the root canal.

Table 1. Distribution of groups according to the type of movement.

Groups	Movement	Files	Tip	Taper
G1 - Protaper Next	Rotary	X1, X2, X3, X4	0.40	06
G2 - Wave One	Reciprocating	Large	0.40	08

After the biomechanical preparation of both groups, the canals were irrigated with EDTA solution for 3 minutes and stirred with ultrasound for one minute to remove the smear layer [10]. The final irrigation of root canals was performed with 10 mL sodium hypochlorite and they were dried with absorbent paper tips [11].

For analyzing the intraradicular wear due to endodontic instrumentation, the specimens were weighed in an analytical balance in order to record the initial weight (P0) of each specimen before the instrumentation.

The teeth were exposed to room temperature for seven days for drying. After this exposure, the initial weighing (P0) of the roots in an analytical balance AY-220 (Shimadzu, São Paulo, SP, Brazil) was performed. After the last instrumentation, the specimens were again exposed to room temperature for another seven days and then the second weighing (P1) was performed.

The difference found between the values attributed to the two weighings of each specimen represented the wear of the dentin walls in order to compare the degree of wear between the study groups.

Statistical Analysis

For analysis of the data, the Statistical Tool PHStat2 (Prentice Hall Inc., New Jersey, USA) and GNU PSPP Statistical Analysis Software were used. In order to analyze the difference between the initial weight and the post-treatment weight of the teeth, the Analysis of Variance – ANOVA was used for comparison of the means, with a significance level of 5%.

Ethical Aspects

This study was approved by the Research Ethics Committee of the Institute of Health Sciences of the Federal University of Bahia (Protocol No. 1,736,909).

Results

The variable considered in this study was the difference between the initial and final weights after the treatment of the canals of the specimens. There was statistically significant difference between the two treatments (Table 2). Thus, the results demonstrate that the treatment with the Wave One system had a higher mean than the treatment with the Protaper Next system with respect to the intraradicular dentin wear.

Table 2. Test results of analysis of variance (ANOVA).

Group	N	Sum	Mean	Variance
Wave-One	24	2.071929	0.08633	0.000184
Protaper	24	1.553878	0.06474	0.000482

Discussion

All phases of endodontic treatment are extremely important, from anamnesis to preservation, and any carelessness may compromise all therapy [12]. One of these essential phases is the biomechanical preparation of the root canal; however, it is necessary to be fully familiar with the instruments used in this step for successful treatment.

The technological advances have given rise to instruments with special metallic alloys, such as nickel-titanium, which allowed modifications in the cross-sectional design and cutting angle of the files. In addition, the tip design was changed, and the dimensions of the endodontic instruments were modified regarding conicity [13]. Mechanized instrumentation promotes faster preparation of the root canal and less stress for the professional and their patients during the treatment [14]. Manual files that used to be the only ones available for endodontic treatment, are more frequently used today for root canal exploration prior to automated mechanical preparation as a way of assuring the internal anatomy of dental units, as in the present study.

With the great advantages presented by the continuous rotary systems, and the significant frequency of use, failures were revealed [2]. In view of this limitation, a technique was developed in which only one file of the Protaper Universal system, F2, was used in all root canal instrumentation based on reciprocating kinematics instead of continuous, in order to simplify the preparation steps and reduce the instrument fatigue [8]. From this proposal of intervention in root canals, several studies were conducted to compare the effectiveness of the continuous and reciprocating movements [1,10,13], emphasizing that the nickel and titanium instruments when used with reciprocating movements showed greater resistance, longer shelf life, greater ability to maintain canal centering, lower apical transport, and less extrusion of dentin remains in the periapex, compared to continuous instrumentation [2].

With regard to the Protaper Next system, it is a new generation of rotary instruments of different sizes and conicities, made with Ni-Ti M-wire. This is a new alloy produced based on an innovative process of heat treatment, a condition that results in benefits such as increased flexibility and better resistance to cyclic fatigue [15]. The increased flexibility of the Protaper Next system with Ni-Ti M-wire technology is the result of a characteristic thermomechanical processing

(consisting of the three crystalline phases, which are deformed and micromilled martensite, R phase, and austenite phase), making the instrument more flexible than conventional Protaper files, as well as more resistant to cyclic fatigue [16]. Ni-Ti files subjected to heat treatment are more flexible and more resistant to fatigue fracture compared to conventionally manufactured instruments [17].

In 2010 an automated instrument was launched, using the reciprocating movement, exemplified by the Wave One system. Besides the reciprocating movement, this system has an instrument with peculiar characteristics, reducing the number of files for all the preparation, since the proposal is to perform the preparation with only one file and, consequently, needs shorter working time and provides better resistance of the instrument [18].

The method of preparing the root canals using only one file that acts in reciprocating movement, performs rotary movements in counterclockwise and clockwise direction, that is: the instrument, when rotating in the cutting direction, advances inside the root canal, contacts the dentin and processes the cut, while when rotating in the opposite direction, it is released immediately [5].

Reciprocating systems, in contrast to rotary systems, produce more dentin wear than rotary systems [19], corroborating with the results of our study. The present study compared different kinematic movements, a reciprocating (Wave One) and a rotary (Protaper Next) and the results obtained can be explained by the differences in kinematics and design between systems. Several factors exert a complex influence on the cutting ability of a file, such as the helical and inclination angle, the metallurgical properties and the surface treatment of the instruments [20].

One aspect in the design of the Protaper Next and Wave One instruments is that the first has a diameter in the first apical millimeters of 0.06 mm, while the latter has 0.08 mm. Both systems are made from the same Ni-Ti alloy (M-wire); however, they have different cross-sections. Wave One files have a section that varies along its long axis, where it has a modified convex triangular cross-section at the tip and a triangular convex section in the middle and coronal portions and has three cutting blades [21]. On the other hand, Protaper Next files have a decentralized rectangular cross-section, creating an enlarged space for removing debris and resulting in asymmetrical movement, where only two edges of the instrument come into contact with the canal wall [22].

Adequate enlargement of the root canal during endodontic therapy is essential, because microorganisms are able to penetrate the dentin tubules. Furthermore, as it is highly organic, the pre-dentin layer must be completely removed during preparation to avoid formation of voids between the filler material and the root canal walls [23]. However, the use of large diameter instruments in mechanical preparation compromises the root canal, causing morphological alterations that may lead to treatment failure [24]. When the apical preparation is conservative it ends up compromising the cleaning of the root canal [23]. Accordingly, the diameter of the instruments used in the present study is consistent with the anatomy of the dental elements chosen.

The standardization of the specimens that were used in the present study was not a limitation in this research, as reported by other authors [25]. Despite the variations in the

morphology of the extracted teeth, each specimen was instrumented with files of equal diameter, ensuring a correct and reliable standardization and comparability of the experimental groups. The decision to use flattened canals was based on the complexity of the mechanical preparation to reach all the root canal walls [26].

The single use of endodontic instruments reduced instrument fatigue and consequently fracture risk [27] and possible cross-contamination associated with the use of Ni-Ti rotary instruments for canal instrumentation [28]. The alternating motion and manufacture of M-Wire alloys are the main characteristics of these single-use instruments [29].

The results of the present study confirmed the superiority of the single instrument reciprocating system over the rotary multi-instrument system [25]. The nickel-titanium systems (ProTaper Next and Wave One) did not present a statistically significant difference in terms of intraradicular dentin wear as previously described [30]. This is not in agreement with the findings of this study.

Methods to evaluate the effectiveness of the cut of instruments in the preparation of the flattened root canal have been used [31]. Some of these are: replication techniques [32], reassembling techniques [33], scanning electron microscopy [34], histological sections [35] and weight loss of acrylic blocks or extracted teeth [36]. In this study, the analytical balance was used to compare differences between pre- and post-endodontic instrumentation and to check root canal dentin wear in treated canals, as previously mentioned [37].

All motor driven systems are used in continuous rotation, and a continuous rotary file is considered a helical conveyor, improving the transport of dentin scrapings and fragments coronally [19]. Protaper Next has a unique design that is a center of mass displacement and rotation. This design offers a better transverse space for cutting, loading, and effectively allowing dentin debris to be carried away from the root canal [38], and therefore it was used as one of the instrumentation techniques for the present study. The Protaper Next files compared to the Universal ProTaper systems, and also to the Wave One [39] group, showed lower extrusion of debris [40]. Protaper Next produced less canal transport than the Wave One system [26], confirming the findings described here.

Conclusion

Most losses of dentin tissue occurred in the group that used the instrument with the Wave One reciprocating file system, thus, proving a greater efficacy of these endodontic instruments in root canal cleaning.

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