EVALUATION OF THE GRADUAL MASS LOSS OF DIFFERENT NICKEL-TITANIUM INSTRUMENTS AFTER REPEATED USE IN SIMULATED CANALS

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ABSTRACT

To evaluate the gradual loss of mass of different nickel-titanium (NiTi) instruments after repeated use in simulated canals. Four different instrument systems were used: Group 1. Protaper Ultimate®; Group 2. Trunatomy®; Group 3. Wave One Gold® and Group 4. Reciproc Blue®. Each instrument in each group was initially weighed on a high-precision digital analytical scale to obtain the initial weight (PI). Each group will perform the instrumentation of five simulated canals with the aid of the X-Smart Plus® electric motor, following each manufacturer's sequence. After this step, a new weighing was performed to obtain the final weight (PF). The gradual loss of mass of each instrument was calculated by the difference between the PI and PF measurements of each instrument. After obtaining the results, a statistical analysis was performed. Having verified the normality of the sample, an analysis of variance ($P < 0.05$) was performed. The Tukey test was then used for multiple comparisons between groups.

Keywords: root canal preparation, dental instruments, kinematics

INTRODUCTION

The advent of nickel-titanium (NiTi) rotary instruments has brought greater safety during root canal shaping, a fact that has led to a considerable increase in their use in recent decades. When the appropriate principles and recommendations are followed, they allow for more centralized preparations, maintaining the original shape of the canal and with higher quality when compared to stainless steel instruments, especially in situations with severely curved canals. Elasticity and the ability to return to their original shape are important characteristics for an endodontic instrument. Due to the complex anatomy of the root canal system and the difficulty of achieving endodontic success, nickel-titanium instruments are essential for preparation, as they follow the path of the root canal (LOPES et al., 2010; ESTRELA et al., 2004; WALIA et al., 1988). The mechanical action of the instrument on the

dentin is an important step during root canal preparation, as it is necessary to remove contaminated dentin and shape the canal to create favorable conditions for proper filling. Due to their elasticity, it can be assumed that the cutting efficiency of NiTi instruments would be lower than that of steel instruments, since they undergo deflection during contact with the dentin surface. However, studies have shown that NiTi instruments have a more efficient cutting capacity when compared to steel instruments.

Although there have been significant advances in rotary instrumentation, the influence of the cutting instrument blade design is still controversial with regard to the efficiency of its cutting and cleaning ability (PETERS, 2004; HÜLSMANN, PETERS, DUMMER, 2005). Their cutting capacity results from a complex interrelationship between different parameters, such as the cross-sectional area of the instrument, radial guides or active cutting blades, metallurgical properties of the alloys (HÜLSMANN, PETERS, DUMMER, 2005; SCHÄFER, 1999; WAN, 2010) as well as the heat treatment of nickel-titanium alloys (RAPISARDA, 2000, 2001). The objective of this study is to evaluate the gradual loss of mass of different NiTi instruments (Protaper Ultimate®, Trunatomy®, Wave One Gold®, and Reciproc Blue®) after repeated use in simulated canals, as assessed by a high-precision digital scale.

METHODOLOGY

Four different instrument systems were used: Group 1 - Protaper Ultimate® (Dentsply Maillefer); Group 2 - Trunatomy® (Dentsply Maillefer) Group 3 - Wave One Gold® (Dentsply Maillefer) and Group 4 - Reciproc Blue® (VDW). Each instrument in each group was initially weighed on a high-precision digital analytical scale to obtain the initial weight (PI). A total of 11 instruments were analyzed. Prior to preparing the prototype tooth canals (IM do Brasil Ltda. São Paulo/SP), the instruments were washed in an ultrasonic tank with distilled water and detergent solution in a 10:1 ratio for 20 minutes, dried with a jet of air, and then weighed again to determine the final weight (FW). Each prototype tooth was explored and emptied to the K-file #15 (Dentsply Maillefer, Ballaigues, Switzerland) along its entire length until the file could be seen through the apical foramen. From this length, one millimeter was subtracted to obtain the actual working length of each sample, using the incisal edge as the reference point for this determination. After the emptying and exploration stage, the

teeth were randomly distributed into four groups (n=10) according to the rotary system designated for root preparation, with enlargement of the cervical and middle thirds prior to root canal instrumentation: During the instrumentation of the apical third of the root canals, they were irrigated at each instrument change with 5 ml of distilled and deionized water, using a 5 ml Ultradent syringe coupled to a Navitip irrigation cannula (Ultradent Products Inc. 505 West 10200, South,South Jordan, UT 84095) until reaching the working length, according to the manufacturer's guidelines for the system used in this study. The washing and drying procedure of the tested instruments was performed after instrumentation to determine the final weight (FW). The gradual loss of mass of each instrument was calculated by the difference between the PI measurement and the FW of each instrument. After obtaining the results, a statistical analysis was performed. Nonparametric data distribution was verified by the Shapiro Wilk test ($p > 0.05$). The ANOVA test was subsequently used for multiple comparisons between groups.

RESULTS

The results are shown in the table below according to the averages obtained in grams (g) between the initial (P1) and final (P2) weights.

Table 1. Average initial (P1) and final (P2) weights expressed in grams (g) in the different groups tested.

Experimental group (n=10)	Average (grams) Initial weight (P1)	Average (grams) Final weight (P2)	p value
G1. TRU	$0.340^{A,a}$	$0.340^{A,a}$	0.479
G2. PU	$0.409^{B,b}$	$0.409^{B,b}$	0.322
G3. WOG	$0.231^{C,a}$	$0.231^{C,a}$	0.05
G4. REC BLUE	$0.356^{D,d}$	$0.316^{E,a}$	**0.001**
Valor de p	**p<0,01**	**p<0,01**	

*Different letters indicate statistically significant differences between groups (p<0,05). *Different lowercase letters in the column indicate significant differences (p<0,05).

*Different capital letters in the rows indicate significant differences (p<0,05).

TRU - Trunatomy; PU – Protaper Ultimate; WOG – Wave One Gold; REC BLUE – Reciproc Blue

CONCLUSION

Based on the results obtained, it was concluded that there were no significant differences between periods P1 and P2 for groups G1, G2, and G3, except for group G4. In intergroup comparisons, differences were observed between G1, G2, and G4 in P1, and between G1, G2, G3, and G4 in P2. In addition, fractures occurred in reciprocating instruments, with WOG presenting a fracture on the sixth use and REC BLUE on the ninth use.

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