

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

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ABSTRACT

The aim of this study was to evaluate the gradual mass loss of different nickel-titanium (NiTi) instruments after repeated uses 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 from each group was initially weighed on a high-precision digital analytical scale to obtain the initial weight (IW). Each group performed the instrumentation of five simulated canals using the X-Smart Plus® electric motor, following each manufacturer's sequence. After this step, a new weighing was performed to obtain the final weight (FW). The gradual mass loss of each instrument was calculated by the difference between the IW and FW of each instrument. After obtaining the results, statistical analysis was performed. After verifying the sample normality, an analysis of variance ($P < 0.05$) was performed. The Tukey test was then used for multiple comparisons between the groups.

Keywords: root canal preparation, dental instruments, kinematics

INTRODUCTION

The advent of rotary nickel-titanium (NiTi) instruments has brought greater safety during root canal shaping, leading to a considerable increase in their use over the past decades. When following the proper principles and recommendations, they allow for more centralized preparations while maintaining the original shape of the canal and with higher quality compared to stainless steel instruments, especially in cases of severely curved canals. The elasticity and 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 in 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 is lower than that of steel instruments, as they undergo deflection during contact with the dentin surface. However, studies have shown that NiTi instruments have a more efficient cutting capacity compared to steel instruments.

Although significant advances have been made in rotary instrumentation, the influence of the instrument blade design is still controversial regarding its cutting and cleaning efficiency (PETERS, 2004; HÜLSMANN, PETERS, DUMMER, 2005). Their cutting efficiency results from a complex interrelationship between various parameters such as the instrument's cross-sectional area, 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 mass loss of different NiTi instruments (Protaper Ultimate®, Trunatomy®, Wave One Gold®, and Reciproc Blue®) after repeated uses in simulated canals, as assessed using a high-precision digital scale.

METODOLOGIA

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 from each group was initially weighed on a high-precision digital analytical scale to obtain the initial weight (IW). A total of 11 instruments were analyzed. Before performing the preparation in the canals of the prototyped teeth (IM do Brasil Ltda. São Paulo/SP), the instruments were washed in an ultrasonic bath with distilled water and detergent solution in a 10:1 ratio for 20 minutes, dried with an air jet, and then weighed again to determine the final weight (FW). Each prototyped tooth was explored and emptied up to the K-file #15 (Dentsply Maillefer, Ballaigues, Switzerland) along its entire length, until the file was visible through the apical foramen. From this length, one millimeter was retracted to obtain the real working length for each sample, with the reference

point being the incisal edge. After the exploration and cleaning step, the teeth were randomly distributed into 04 groups (n=10) according to the rotary system designated for root canal preparation, enlarging the cervical and middle thirds before canal instrumentation. During the instrumentation of the apical third of the root canals, they were irrigated with 5 mL of distilled and deionized water using a 5 mL Ultradent syringe connected to a Navitip irrigation cannula (Ultradent Products Inc. 505 West 10200, South, South Jordan, UT 84095) until the working length was reached, as per the manufacturer's instructions for the system used in this study. The procedure for washing and drying the tested instruments was performed after instrumentation to determine the final weight (FW). The gradual mass loss of each instrument was calculated by the difference between the IW and FW of each instrument. After obtaining the results, statistical analysis was performed. The data distribution was checked using the Shapiro-Wilk test ($P < 0.05$). The ANOVA test was then used for multiple comparisons between the groups.

RESULTS

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

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

Experimental Group (n=10)	Average (grams) Initial Weight (P1)	Average (grams) Final Weight (P2)	p-value
G1. TRU	0.340A,a	0.340A,a	0.479
G2. PU	0.409B,b	0.409B,b	0.322
G3. WOG	0.231C,a	0.231C,a	0.05
G4. REC BLUE	0.356D,d	0.316E,a	0.001
p-value	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 uppercase letters in the rows indicate significant differences ($p < 0.05$).

CONCLUSION

Based on the obtained results, it is concluded that there were no significant differences between periods P1 and P2 for groups G1, G2, and G3, except for group G4. Intergroup comparisons revealed differences between G1, G2, and G4 in P1, and between G1, G2, G3, and G4 in P2. Furthermore, fractures occurred in reciprocating instruments, with WOG fracturing after the sixth use and REC BLUE after the ninth use.

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