Cutting behavior of three different NiTi endodontic instruments

The objective of the endodontic treatment is cleaning and shaping the root canal system allowing ideal irrigation and obturation. This preparation and disinfection are accomplished by the cutting action of rotary endodontic instruments with the help of a lubricant solution, normally sodium hypochlorite (NaOCl), which also functions as bactericide and organic tissue solvent.

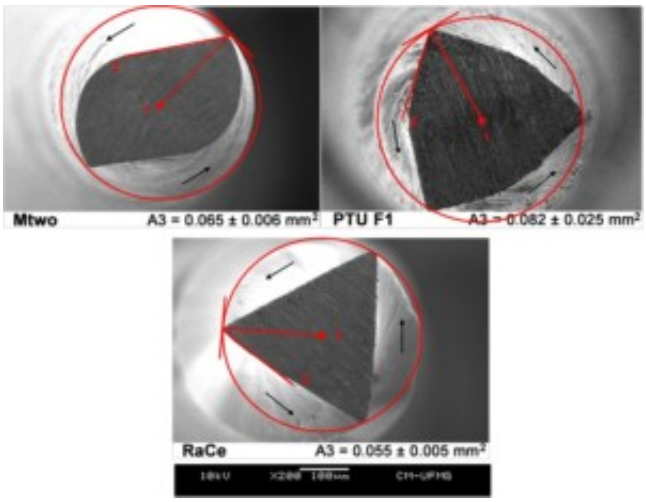

Fig. 1. Scanning electron microscopy images of the cross section at 3 mm from the tip of the instruments evaluated. Mean values of the cross-sectional areas (mm2) are shown in the insets.

Nickel-titanium (NiTi) rotary instruments for root canal instrumentation have enabled clinicians to more predictably and efficiently create tapered preparations, while minimizing procedural mishaps, especially in curved canals. Nowadays, endodontic instruments come in a variety of designs, each differing in cost, performance, and safety. One important attribute is the cutting efficiency of an instrument. However, there is no consensus regarding the most adequate criteria to assess the cutting efficiency of endodontic instruments. The torque and apical force required for the penetration of the instrument inside an artificial canal seem to be reasonable variables to measure its cutting properties.The metallurgical properties of the NiTi alloy used in the manufacture of the instrument certainly influence its performance, but the flute, cross-sectional design, and dimensions, in particular the pitch length (distance between a point on the leading edge and the corresponding point on the adjacent leading edge), rake angle, and cross-sectional area, are the determining factors that give a certain instrument its cutting properties.

The purpose of this study was to assess the cutting properties using a recently developed methodology based on measurements of the torque and apical force at a constant insertion rate in

experiments performed in a laboratory bench device. The use of a fixed rate of feeding the instrument into the artificial canal eliminates this important variable in the test and simplifies the data analysis. By considering 3 brands of commercially available NiTi files with different design features, the role of the pitch length, cross-sectional area, and rake angle was taken into account in an attempt to assess their clinical relevance.

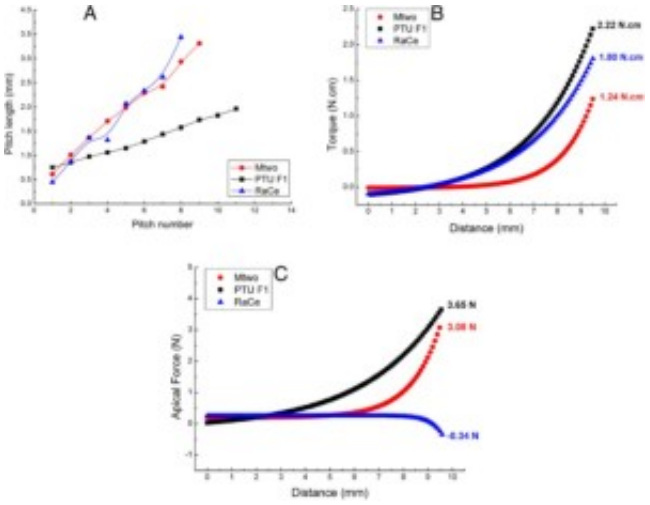

Fig. 2. (A) Variation in the pitch length, (B) relationship between torque and instrument penetration (showing mean values of maximum toque), and (C) relationship between apical force and instrument penetration (showing mean values of maximum apical force).

The insertion tests at a constant rate of 5.4 mm/min were performed by measuring the torque and apical force required for penetrating prefabricated acrylic blocks containing an artificial canal preflared with #10 and #15 K-files. Size 20/.06 Mtwo (VDW, Munich, Germany) and RaCe (FKG, La-Chaux De Fonds, Switzerland) instruments, together with ProTaper Universal (PTU) F1 instruments (Dentsply Maillefer, Ballaigues, Switzerland) (10 instruments of each type), were tested using an endodontic motor set at a speed of 300 rpm and 5 Ncm of maximum torque. The instruments were characterized with respect to the pitch length, rake angle, and cross sectional area (Fig. 1, 2). Statistical analysis was performed with analysis of variance (a = 0.05). The torque was significantly lower for Mtwo compared with the other 2 groups (P less than 0.05). It was also lower for RaCe in comparison with PTU F1 (P less than 0.05). Regarding the apical force, the RaCe instruments had lower values when compared with the Mtwo and PTU F1 instruments(P less than 0.05).The alternated cutting edges of the Race instruments are constructed in such a way they do not simultaneously contact the root canal walls. This feature probably influenced the apical force values measured for this file, which were initially low and then became negative. There was no statistically significant difference between the PTU F1 and Mtwo instruments (P > 0.05) (Fig. 2.). In Summary, the methodology allowed the cutting properties of the instruments to be assessed in terms of their different geometric characteristics. The cross-sectional design, especially in Mtwo

instruments with 2 sharp edges and great chip removal capability, was a differential factor for their higher cutting action.

Publication

Constant Insertion Rate Methodology for Measuring Torque and Apical Force in 3 Nickel-Titanium Instruments with Different Cross-sectional Designs.
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