Investigation on the Shaping Ability of Nickel-Titanium Files When Used with a Reciprocating Motion

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Abstract

Introduction: The introduction of nickel-titanium (NiTi) files into clinical practice has improved the quality of canal shaping, but increasing the curvature of the root canal (or the diameter of the master instrument that prepares the full working length) could result in more transportation, straightening, and aberration of the canal. Nickel-titanium instruments are significantly safer and have an extended cyclic fatigue life when used with a reciprocating movement. The purpose of this study was to compare the shaping ability of FlexMaster NiTi instruments when used in either continuous or reciprocating movements. **Methods:** Thirty-two Endo Training Blocks ISO 15, 2% taper, 10-mm radius of curvature, and 70° angle of curvature were prepared, according to the group, with FlexMaster NiTi instruments either in continuous rotation or in reciprocating (60° clockwise, 40° counterclockwise) movement. Preoperative and postoperative images of the simulated canals were taken under standardized conditions. The preoperative and postoperative images were combined exactly. The amount of resin removed was determined both for the inner (convex) and the outer (concave) sides of the curvature at 10 different points. **Results:** In the most apical third of the canal, the Continuous group produced the largest enlargement of the canal as compared with the Reciprocating group ($P < .05$). In the apical third, the Continuous group displayed significantly greater enlargement of the canal at the external side. **Conclusions:** The shaping of simulated canals is more centered by using a reciprocating motion when compared with continuous rotation, but the reciprocating motion could be more time-consuming. *(J Endod 2011;37:1398–1401)*

Key Words

Dental instruments, dental models, instrumentation methods, NiTi

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A continuously tapering funnel shape that follows initial anatomy, with the smallest diameter at the end point and the largest at the orifice, is a prerequisite to remove all the pulp tissue, bacteria, and their by-products, while providing adequate canal shape to fill the canal (1, 2).

The introduction of rotary nickel-titanium (NiTi) endodontic instruments (also called files) into clinical practice has improved the efficacy of endodontic practice in terms of procedural time, accuracy, and risk reduction, compared with the previously used manual stainless steel files (3–5).

Because of their flexural properties, coupled with the design of the blades, it is feasible to use NiTi files with a handpiece in a rotary motion to prepare root canals (6). Meanwhile, almost all published findings are in consensus that increasing the curvature of the root canal or the diameter of the master instrument that prepares the full working length (WL) results in more transportation, straightening, and aberration (7). Usually NiTi instruments were designed for use with continuous rotation movement at low speed.

Malentacca and Lalli (8) observed that NiTi instruments were significantly safer when used with a reciprocating movement than when used with continuous rotation. A subsequent study showed that the incidence of instrument fracture in blocks of resin was lower with alternating rotation than with continuous rotation (9).

The reciprocating movement also promotes an extended cyclic fatigue life of the instruments when compared with conventional rotation (10, 11).

Yared (12) proposed a shaping technique based on the use of a F2 ProTaper (Tulsa Dentsply, Tulsa, OK) with reciprocating movement. Flex Master instruments have the same cross section as ProTaper, but they have a continuous taper throughout the whole length of the instrument rather than a variable taper.

No studies are currently available on the shaping ability of files designed for the continuous rotation when they are used with reciprocating movement.

The aim of this study was to compare the shaping ability of Flex Master NiTi instruments by using 2 different rotation movements, with the working hypothesis that they have a similar shaping performance.

Materials and Methods

Thirty-two Endo Training Blocks ISO 15 (Dentsply Maillefer, Ballaigues, Switzerland), 2% taper, 10-mm radius of curvature, and 70° angle of curvature, were used to assess instrumentation.

Specimens were randomly assigned to 2 different groups by using a random generated numbers table. Each specimen was mounted in a support, which was made for the study, in a stable vertical position and digitally photographed consistently under the same light condition before starting the instrumentation phase.

Preparation of Simulated Canals

After photography, the transparent blocks were covered with black adhesive tape to conceal the preparation during the instrumentation stage. The simulated canals were prepared, according to the group, with FlexMaster NiTi instruments (VDW, Munich, Germany) either in continuous rotation or in reciprocating (60° clockwise, 40° counterclockwise) movement. Glycerin was used as a lubricant, and copious irrigation with water was performed after the use of each file. Canal patency was checked between instrument changes with a K-Flexofile #10 (Dentsply Maillefer).

Continuous Group

FlexMaster instruments were set into continuous rotation (280 rpm) with a 6:1 reduction handpiece (Sirona, Bensheim, Germany) powered by a torque-limited electric motor (VDW silver) with the appropriate torque for each file (90 g-cm for 0.06 taper (T) size 25, 60 g-cm for 0.04T size 25, 30 g-cm for 0.04T size 15), as recommended by the manufacturer. The motor was set to work with the Automatic Stop and Reverse function on (ie, when the preset torque is reached, the micro-motor will turn automatically in reverse direction until the file no longer encounters resistance, at which point it will automatically revert to forward rotation). Instrumentation was completed by using a gentle in-and-out motion.

The adopted file sequence was 0.04T size 15 (at WL), 0.06T size 25 (5 mm short of the WL), 0.04T size 25 (at WL), and 0.06T size 25 (at WL).

Reciprocating Group

FlexMaster instruments were set into reciprocating movement (60° clockwise, 40° counterclockwise, 280 rpm) with a 16:1 reduction handpiece (Sirona) powered by a torque-limited electric motor (Sirona Pocket; Sirona). The maximum torque (5 Ncm) was used for all the instruments. Instrumentation was completed by using a gentle in-and-out motion. Instruments were withdrawn when resistance was felt.

The same file sequence as in the Continuous Group was used.

All canals were shaped by an operator experienced in NiTi instrumentation. All instruments were used to shape 2 canals only. Measurements of the canals were carried out by a second examiner who was blinded with respect to all the experimental groups.

Assessment of Canal Preparation

Preoperative and postoperative images of the simulated canals were taken under standardized conditions with a digital reflex (Fuji S2 Pro; FujiFilm, Tokyo, Japan), mounted on an operative microscope (Leica M655; Leica Microsystems, Wetzlar, Germany).

The postoperative images were taken when the 0.06T size 25 reached the WL. The preoperative and postoperative images were combined exactly in 2 different layers by using Photoshop software (Adobe Systems, San Jose, CA).

Instrument Failure

Instruments were examined under microscopic magnification (Leica M655) after every use. In case of deformation or fracture of an instrument before the end of the second shaping procedure, the Endo Training Block would be substituted, and the shaping would be repeated by using a new instrument.

Preparation Time

The effective working time (considering only the operative phases, when the instrument was actually working inside the simulated root canal) was recorded with a digital chronograph with a precision of 0.1 seconds.

Canal Blockage

In case of excessive formation of resin debris in the canal that prevented the completion of the procedure, the canal would be discarded and not considered for the analysis.

Recording, Storage, and Analysis of Data

The assessment of preparation shape was carried out with the computer program Image (UTHSCSA Image Tool version 3.00 for Windows; University of Texas Health Science Center in San Antonio, TX). The amount of resin removed, eg, the difference between the canal configuration before and after instrumentation, was determined for both the inner (convex) and the outer (concave) sides of the curvature. Measurements were performed in correspondence of 10 consecutive points on the outer and the inner surfaces of the canal. To facilitate the measurement procedure, a grid composed of 10 consecutive concentric circles was superimposed to each image. The distance between any 2 consecutive points was 1 mm. Measurements started 1 mm away from the apical end of the canal. The linear distance between the intersection of each circle line with the border of the original canal shape and the corresponding point on the canal after preparation, along the line orthogonal to the canal axis, was measured. A total of 20 distances at 20 measuring points (10 on the inner side and 10 on the outer side) were recorded for each canal. Each measurement had an accuracy of ±0.01 mm (13–15).

Mean values and standard deviations were calculated for each measurement point. The unpaired Student's t test was used to compare results between the 2 groups. The differences between the results at the inner and outer sides of the canal within each group were analyzed with the paired Student's t test. A value of $P = .05$ was used as the significance level. The data will be discussed

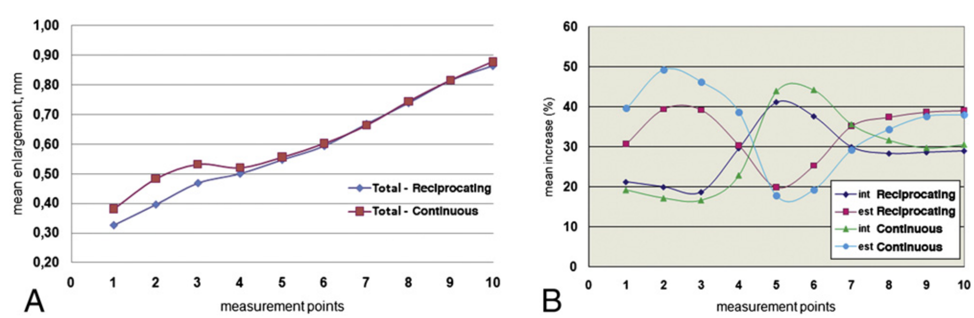

Figure 1. (*A*) Mean total enlargement of canal produced by the 2 techniques. In the most apical third, the continuous technique produced a significantly greater enlargement as compared with the reciprocating technique. (*B*) Mean variation at inner and outer sides of the canal, expressed as percentage of baseline width. The trend is not the same for inner and outer sides, while it is similar between the 2 techniques, although significant differences were found according to the region of the canal. est, outer side; int, internal side.