Effect of the Glide Path Establishment on the Torque Generation to the Files during Instrumentation: An *In Vitro* Measurement

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Abstract

Introduction: The purpose of this study was to compare *in vitro* torque generation during instrumentation with or without glide path establishment. **Methods:** Endo-training resin blocks with J-shaped canals were randomly divided into 2 groups according to glide path establishment (with or without) and subdivided into 2 subgroups with shaping instruments (WaveOne [Dentsply Maillefer, Ballaigues, Switzerland] or WaveOne Gold [Dentsply Maillefer]) (n = 15). For the glide path–established group, the glide path was prepared using ProGlider (Dentsply Maillefer). During the instrumentation with WaveOne or WaveOne Gold, *in vitro* torque was measured. The acquired data were analyzed with software. The maximum torque and total torque (the sum of the generated torque) were calculated. The data were statistically evaluated using 2-way analysis of variance and the Duncan post hoc comparison to examine any correlation of torque generation with glide path establishment and nickel-titanium instruments. The significance level was set at 95%. **Results:** The generated total torque by WaveOne Gold was significantly reduced by glide path establishment (P < .05), whereas glide path establishment did not induce significant changes in the maximum torque for both file systems. WaveOne Gold with a glide path showed the lowest total torque generation among all groups (P < .05). WaveOne generated a higher maximum torque than WaveOne Gold regardless of the establishment of a glide path (P < .05). **Conclusions:** Under the limitations of this study, glide path establishment and the mechanical property of instruments have a significant influence on torque generation. It is recommended to create the glide path and use a flexible file to reduce torque generation and, consequently, the risk of file fracture and root dentin damage. *(J Endod 2017;■:1–5)*

Key Words

Glide path, *in vitro* torque, nickel-titanium instrument, torsional resistance, torsional stress

Significance

Glide path establishment before the use of nickel-titanium shaping instruments may reduce torque generation during the movement of instruments. It implicates the importance of glide path preparation in clinical endodontics.

The advantages of nickel-titanium (NiTi) rotary files compared with stainless steel files are widely known (1–4). Because of the superelasticity and low elastic modulus of the NiTi alloy, NiTi rotary files are able to maintain the original canal during the canal shaping procedure and produce less procedural errors and more predictable and favorable results than stainless steel files (1, 5). Despite all of these advantages, clinicians are still afraid of using NiTi files because of the fracture risk. Fracture of NiTi rotary files occurs with 2 mechanisms (6, 7). Cyclic fatigue fracture occurs when the NiTi file rotates along the curvature, generating repeated tension and compression stresses and fatigue crack propagation. Although the torsional fracture occurs when part of the instrument binds in the canal, the engine continues to rotate, generating stresses beyond the ultimate strength of the material.

Glide path preparation is considered a crucial step for mechanical preparation (8–10). A glide path of sufficient size may reduce the torsional stress of rotating the NiTi file, reducing the potential risk of torsional fracture and increasing the life span of the NiTi file (8). Creating a glide path has some other advantages such as decreasing root canal transportation and producing less apically extruded debris (11–13).

The market is replete with various brands of new NiTi instruments that purportedly are more resistant to fracture. The recently introduced WaveOne Gold

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system (Dentsply Maillefer, Ballaigues, Switzerland) has a different geometric design and dimensions compared with the original WaveOne system (Dentsply Maillefer). The manufacturer claims that this new file is made of "gold wire" that received specialized heat treatment to improve the mechanical properties. Many studies of the WaveOne Gold reciprocation file system showed improved fatigue resistance compared with other reciprocation file systems made of M-wire such as WaveOne and Reciproc (VDW, Munich, Germany) (14, 15). However, there is a scarcity of studies regarding the torsional resistance of heat-treated NiTi files.

The magnitude of the torque generated within the NiTi instrument during canal instrumentation is influenced by the contact area between the file and the canal wall, the applied apical force, and the preoperative canal volume (16). Decreasing the contact area and increasing the total volume of canal by preparing a glide path may reduce the torque generation and stress to dentin. Heat-treated NiTi material is considered to have a relatively low resistance to torsional stress (17, 18); therefore, the importance of glide path preparation should be further emphasized. The manufacturer recommends creating a glide path before the WaveOne Gold system is used.

To date, few studies have examined torque generation during canal shaping procedures in the root dentin using a stress strain gauge (19–21). However, no report is available on the simultaneous torque measurement during canal shaping, probably because of the difficulty in making actual torque measurements. The purpose of this study was to compare *in vitro* torque generation during canal shaping with or without glide path establishment.

Material and Methods

Sixty Endo-training resin blocks (REF A 0177, Dentsply Maillefer) with a curvature of 35°, an initial size of ISO #15, and a 0.02 taper were used in this study (Fig. 1). The working length was determined as 0.5 mm short of the canal exit under an operating microscope (Leica S6D; Leica Microsystems, Wetzlar, Germany) for a length of 16.5 mm. A pilot study had been conducted to calibrate and determine the pecking depth, the total number of "pecks," and speed, which were parameters imported in the main test.

Artificial canal resin blocks with J-shaped canals were randomly divided into 2 groups according to glide path establishment or not and then further divided into 2 subgroups according to the shaping files used (WaveOne Primary vs WaveOne Gold Primary) ($n = 15$ each). The glide path was prepared using the ProGlider (Dentsply Maillefer) NiTi file. All instruments were used in an endodontic engine (X-smart Plus, Dentsply Maillefer) at the suggested setting (300 rpm, 5 Ncm) with the designated modes of continuous rotation or reciprocating.

The reciprocating instrumentation procedure using WaveOne and WaveOne Gold consisted of no more than 15 pecking strokes, with each pecking depth limited to less than 2 mm. After every 3 strokes, the debris was removed from the flutes of the NiTi file, and the artificial canal was irrigated with saline. Generally, the working length was attained at the 12th stroke (Fig. 2*A*); the total instrumentation time was limited to less than 1 minute. During the process, the generated torque was recorded at a rate of 100 Hz using customized software. The data acquired were analyzed in software (Origin v6.0 Professional; Microcal Software Inc, Northampton, MA) to produce a plot. The maximum torque and total torque (value calculated by integrating the plot of torque changing) were computed using this software.

The collected data were initially analyzed to evaluate the normality of distribution. Then, the data were statistically evaluated using 2-way analysis of variance followed by Duncan post hoc comparisons to examine any correlation of torque generation between glide path preparations and the types of NiTi files. The significance level was set at 95%, with the analysis conducted using the SPSS software (Version 22.0; IBM, Armonk, NY).

Results

Torsional stresses were generated in the instrument during each downward "peck." Once the file reached the working length, large and notable amounts of reduction in the maximum torque were observed (Fig. 2*B* and *C*).

The generated total torque value and the maximum torque were computed (Tables 1 and 2). The generated total torque by WaveOne Gold was significantly reduced by glide path preparation ($P < .05$), whereas glide path establishment did not induce significant changes in maximum torque for both file systems. WaveOne Gold with a glide

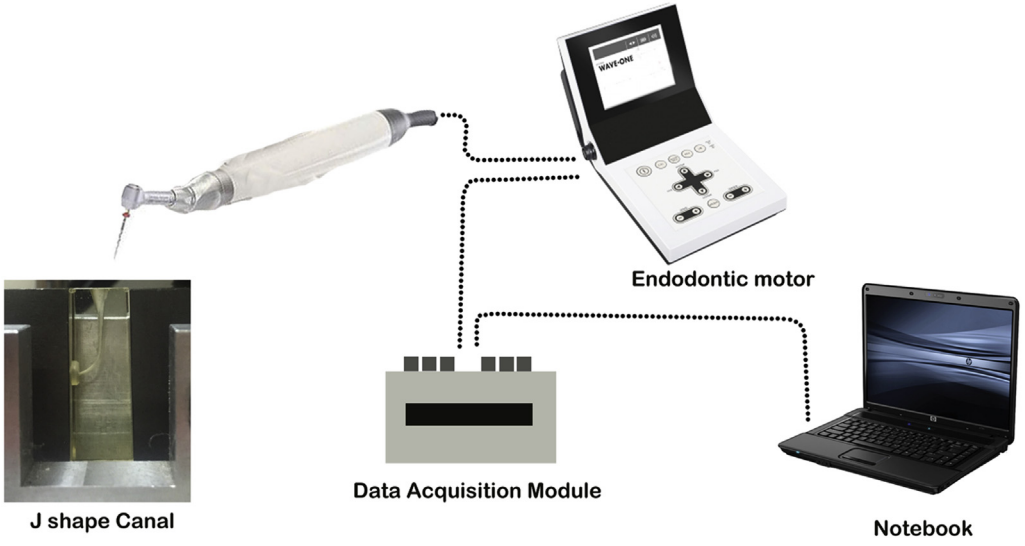

Figure 1. The experimental setting for *in vitro* torque measurement. An artificial canal resin block was fixed in a metal jig, and the instrumentation was conducted. The data acquisition module enables the collection of real-time torque data from the endodontic motor during instrumentation.