Shaping Ability of Different Nickel-Titanium Systems in Simulated S-shaped Canals with and without Glide Path

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Abstract

Introduction: The objective of this study was to compare the shaping ability of different rotary and reciprocating nickel-titanium file systems with and without previous glide path preparation in simulated S-shaped canals. **Methods:** One hundred twenty S-shaped canals in resin blocks were prepared to an apical size 25 by using Reciproc, WaveOne, HyflexCM, F360, and OneShape systems either with or without previous glide path preparation (Pathfile) (12 canals/group). Material removal was measured at 20 measuring points, beginning 1 mm from the end point of preparation. Incidence of canal aberrations (zip/elbow, ledge formation), preparation time, and instrument failures were also recorded. Statistical analyses were performed by using analysis of variance and Tukey and χ^2 tests. **Results:** For all systems, glide path preparation exerted no significant effect on preparation times ($P > .05$). Glide path preparation had no influence on the incidence of canal aberrations and instrument fractures ($P > .05$), with no significant differences between the 5 systems ($P > .05$). Glide path preparation had no influence on the centering ability of all systems ($P > .05$). On average, canals prepared with F360, OneShape, and HyflexCM remained better centered compared with those enlarged with WaveOne and Reciproc. **Conclusions:** Under the conditions of this study, glide path preparation had no significant impact on canal straightening. Less tapered instruments maintained the original canal curvature better than instruments having greater tapers. *(J Endod 2014;40:1231–1234)*

Key Words

Canal transportation, glide path, nickel-titanium, reciprocating, rotary, single-file systems, taper

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Maintaining the original canal shape and avoiding canal aberrations like ledge formation and zip configuration is challenging, especially when preparing severely curved root canals. Nickel-titanium (NiTi) instruments are claimed to shape root canals more effectively than stainless steel instruments because they have 2–3 times greater flexibility (1). In addition, NiTi instruments maintain the original canal anatomy and the position of the apical foramen better than stainless steel instruments (2). Although several techniques have been proposed to reduce the incidence of procedural errors, still any technique invariably leads to a certain degree of canal straightening (2, 3).

The impact of a glide path on the shaping ability of different instruments is discussed controversially. Scouting a canal system and checking apical patency with stainless steel hand files are often proposed and provide additional information concerning the 3-dimensional shape of a root canal because the instrument remains permanently deformed when removed from the curved canal (3, 4). Recently, rotary NiTi files (eg, Pathfile; Dentsply Maillefer, Ballaigues, Switzerland) became available, and the use of these rotary instruments resulted in improved centering ability and reduction of canal aberrations when compared with manual preflaring or hand-operated scouting instruments (5, 6).

The reciprocating single-file systems Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Maillefer) are known to cause only little canal transportation because of the increased flexibility of the M-wire NiTi alloy (7) and the alternating counterclockwise (cutting) and clockwise (releasing) movements of the instruments (8). Other recently launched single-file systems are F360 (Komet, Lemgo, Germany) and OneShape (Micro-Méga, Besançon, France). The working motion of these instruments is a permanent clockwise rotation (9). Both instruments are made of conventional NiTi, and promising results concerning their shaping ability and apical debris extrusion have been described (9, 10).

Other recently introduced instruments are the HyflexCM files (Coltène/Whaledent, Altstätten, Switzerland). This is a full-sequence rotary system, and the files are ground out of CM wire. This alloy has a lower percentage in weight of nickel (52.1%wt) than conventional NiTi alloys (11). A specific heat treatment during the manufacturing process (12) results in increased flexibility and higher fatigue resistance of the instruments (13, 14).

The aims of this study were (1) to assess the impact of glide path preparation on the shaping ability of 4 different single-file systems and 1 full-sequence rotary system and (2) to evaluate the shaping effects of these instruments in simulated S-shaped canals.

Materials and Methods

S-shaped Endo-Training Blocks (Dentsply Maillefer) were used. The taper of these instruments was .02, the apical diameter was 0.15 mm, and the length was 16 mm. The angle and radius of curvatures were 35° and 5 mm for the coronal curvature and 30° and 4.5 mm for the apical curvature, respectively (15–17). Each block was photographed with a digital light-microscope (Müller-Optronic, Expert DN, Erfurt, Germany) at a 40-fold magnification before and after instrumentation in a standardized manner. The first measuring point was 1 mm away from the apical ending of the canal, and the last measuring point was 10 mm from the apical end, resulting in 10 measuring points at the outer side and 10 points at the inner side of the canal (Fig. 1). Thus a total of 20 measuring points were defined. The digital images of all specimens before instrumentation were obtained and saved as tiff-format files. The resin blocks were then randomly assigned to 10 different groups ($n = 12$).

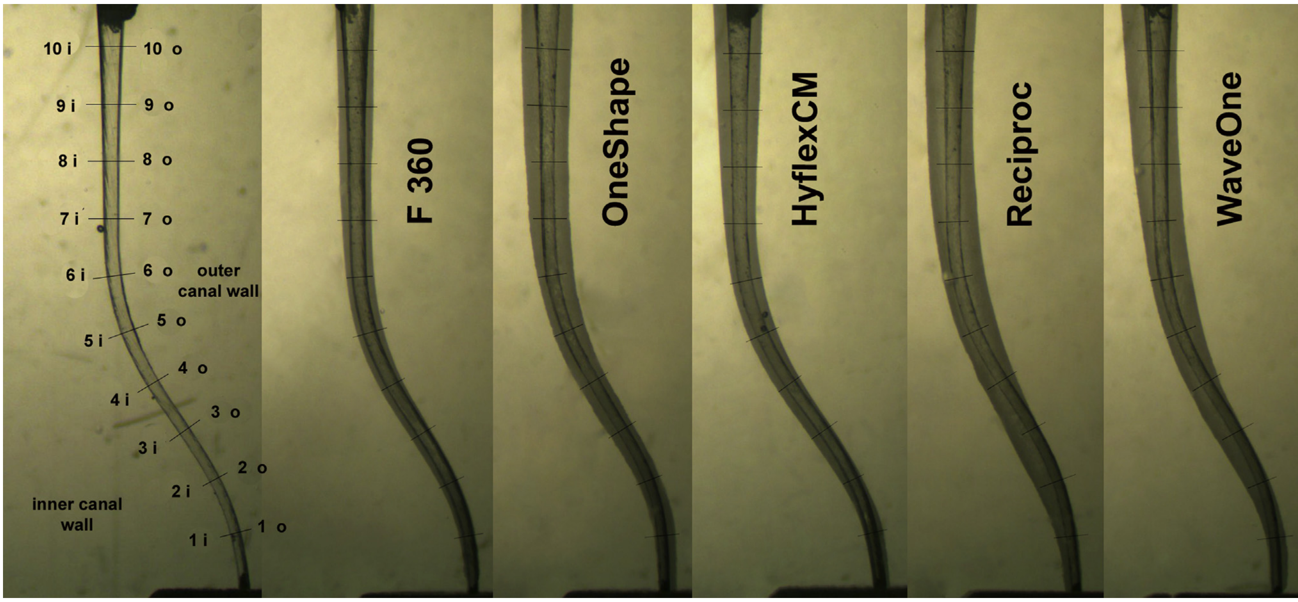

Figure 1. Localization of measuring points and exemplary preinstrumentation and postinstrumentation superimposed pictures of resin blocks after instrumentation with the different instruments.

In one-half of the simulated canals (n = 60), a glide path to full working length was created by using NiTi rotary PathFile instruments (Dentsply Maillefer) sizes 13 and 16 set into rotation with an electric torque-controlled device (VDW Silver; VDW), with the recommended settings according to the manufacturer's instructions.

No glide path was created in the other half of the simulated canals (n = 60). Each canal was shaped with one of the file systems according to the manufacturers' instructions by using the settings in the library of the electronic motor (VDW Silver RECIPROC) or by programming the recommended torque and rotational speed settings manually. Hence, a total of 120 simulated root canals were instrumented (the blocks were covered with tape during the preparation phase) by one operator experienced in preparation with the different types of instruments. A random sequence was used to avoid bias toward 1 of the 5 instrumentation systems.

F360

An F360 file with size 25 at the tip and taper of .04 was used in a gentle in-and-out motion with a rotational speed of 300 rpm, and the torque was adjusted to 1.8 Ncm.

OneShape

A classic OneShape file with size 25 and taper of .06 was used in a gentle in-and-out motion with a rotational speed of 400 rpm, and the torque was adjusted to 4 Ncm.

WaveOne

The primary WaveOne with size 25 at the tip and taper of .08 over the first 3 mm was used in a reciprocating working motion generated by the motor in a slow in-and-out pecking motion (amplitude less than 3 mm).

Reciproc

A R25 file with size 25 at the tip and taper of .08 over the first 3 mm was used in a reciprocating working motion in a slow in-and-out pecking motion (amplitude less than 3 mm).

HyflexCM

The instruments were used in a gentle in-and-out motion with a rotational speed of 500 rpm, and the torque was adjusted to 2.5 Ncm. All instruments were used in a crown-down manner in the following sequence: 25.08 used to two-thirds of working length, and 20.04 and 25.04 used to full working length.

Once the instrument had negotiated to the end of the canal, it was removed. Concerning the single-file systems, irrigation and cleaning of the flutes were performed after 2 in-and-out-movements (pecks) to enhance debris removal. All instruments were used to enlarge 2 canals only except OneShape files, which were used for 1 canal only because of visible deformation of the flutes.

Irrigation was done with 2 mL distilled water after each instrument by using a 31-gauge Navi-Tip flexible irrigation needle (NaviTip 31ga side port; Ultradent, South Jordan, UT). The needle was inserted as deep as possible into the root canal without binding. Although known to be less effective than flat needles, NaviTip needles were selected because of their flexibility ensuring sufficient insertion of the needle into the S-shaped canals. Instruments were used to enlarge 2 canals only. During all preparation procedures, liquid glycerin was used as a lubricating agent.

By using digital imaging software (Adobe Photoshop CS4; Adobe Systems Inc, San Jose, CA), the preinstrumentation and postinstrumentation digital images were superimposed, and the material removal was measured 1-dimensionally at each measuring point (MP) with a precision of $\pm$0.01 mm by using the NIH ImageJ software (National Institutes of Health, Bethesda, MD; public domain). All measurements were made at right angles to the surface of the canal by an examiner who was blinded in respect to all experimental groups. The amount of resin removed at the inner side was denoted as R_{inner}, and the material removed at the outer side was denoted as R_{outer}. Canal transportation was assessed by creating the difference R_{inner}–R_{outer}.

Canal aberrations (ledge, apical zip), instrument fractures, and preparation times were also recorded. These different types of canal aberration were defined according to the detailed descriptions published previously (15). The time for canal preparation was recorded and included total active instrumentation, instrument changes within the