Journal of Dental Sciences (2017) xx, 1–5

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

ORIGINAL ARTICLE

Canal shaping of different single-file systems in curved root canals

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Received 17 January 2017; Final revision received 19 February 2017
Available online ■ ■ ■

KEYWORDS
canal curvature;
canal straightening;
endodontics;
reciprocating motion;
single file instrumentation

Abstract *Background/Purpose:* This study compared maintenance of canal anatomy, occurrence of apical transportation, and working time observed after instrumentation with One Shape New Generation rotary system (Micro-Mega), with those observed after instrumentation with Reciproc (VDW) and WaveOne (Dentsply-Maillefer) reciprocating systems.
Materials and methods: The mesial canals of 45 mandibular molars (curvature angles between 35° and 45°) were selected. Specimens were randomly divided into three groups, and canal preparations were performed using One Shape, Reciproc, or WaveOne systems (size #25). A digital double radiographic technique was used to determine apical transportation and change in angle of curvature. Also, working time and instrument failures were recorded. Data were statistically analyzed.
Results: During preparation, no file fractured. No statistically significant differences were found among groups. No system showed a significantly faster preparation time than others ($P > 0.05$). All instruments maintained the original canal curvature well and were safe to use.
Conclusion: Both continuous rotary instrument and reciprocating systems did not have any influence on the presence of apical transportation or caused an alteration in angle of canal curvature.

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http://dx.doi.org/10.1016/j.jds.2017.03.001

Introduction

A new idea was lately realized for nickel-titanium (NiTi) rotary instruments: it consists of using just one instrument with different working motions with the aim to prepare root canals.[1–4] Diverse single-file systems have been promoted with the ability to prepare root canals with just one instrument. The recently introduced NiTi files Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) are made of a special NiTi-alloy called M-Wire which is created by an innovative thermal-treatment process. The benefits of this M-Wire NiTi are based on increased flexibility of the instruments and on improvement of resistance to cyclic fatigue.[5] These files must be used in a reciprocal motion that requires special automated devices. Reciproc files are available in sizes 25—0.8, 40—0.6, and 50—0.5, and WaveOne are available in sizes 21—0.6, 25—0.8, and 40—0.8. The reciprocation working movement lies in a counterclockwise (cutting direction) and a clockwise movement (instrument release), whilst the counterclockwise cutting direction angle is greater than the instrument release one. Because the angle of counterclockwise is greater than the angle of clockwise, it is expressed that the instrument continually progress in the direction of the root canal apex. The One-Shape New Generation file by Micro-Mega (Besancon Cedex, France) is another single-file system, but used in continuous clockwise rotation; in addition to the size 25—0.6, there are Apical files in sizes 30—0.6 and 37—0.6. These instruments, having an innovative design, with three diverse cross-sectional areas above the entire length of the working part do not have a fixed pitch and a noncutting safety tip.[6] The design features of Reciproc, WaveOne,[3] and OneShape have been previously described in detail.[6] Some data are present in literature on the shaping ability of these systems,[2,6] but a comparative evaluation in canals with curvatures of over 35° is still missing.

Therefore, the aim of the present study was to compare the shaping ability of WaveOne, Reciproc, and OneShape single-file systems in severely curved root canals of extracted human molar teeth. The null hypothesis tested was that there is no difference among different single-file systems regarding canal straightening, apical transportation, or preparation time when preparing severely curved root canals.

Materials and methods

Specimen preparation

Forty-five human mandibular molars with curved mesial canals extracted for periodontal reasons were stored in a 0.2% thymol solution until use. The crown and distal root of each tooth were removed approximately at the level of the cementoenamel junction with a diamond rotary cutting instrument mounted on a high-speed handpiece with water-spray cooling, to obtain a mesiobuccal root canal measuring 12 mm in length. Confirmation of foraminal patency was performed with a #08 or #10 stainless steel manual K-type file. To avoid any bias caused by differences in the initial width, all the canals that before any instrumentation could be easily negotiated up to the apex with a #15 (or wider) file, were not included in the study. Accordingly, 45 roots were selected, and the working length was determined by subtracting 1 mm from the length at which a #10 file tip extruded apically.

Keeping the #10 file inside the canal, a series of radiographs were taken following the methodology of Iqbal et al.[7] Adobe Photoshop CS5 software (Adobe Systems Inc., San Jose, CA, USA) was used to enhance the edges of the initial and final instrumentation radiographs.[8] The angle and the radius of the canal curvature were determined according to the method previously described[8] by using a computerized digital image processing system (AutoCAD 2006; Autodesk Inc., San Rafael, CA, USA). The roots whose angles of curvature ranged between 35° and 45° were included in this study and randomly divided into three groups with 15 canals each. There was no need to perform thermal cycling of specimens.[9] The homogeneity of the groups with respect to the aforementioned two parameters was assessed using analysis of variance (Table 1). The roots were embedded in a jig constructed with autopolymerizing acrylic resin (Technovit 4000; Heraeus Kulzer, Wehrheim, Germany) so that they could be removed for preparation and later reinserted in a predetermined position for the purpose of comparing the images taken before and after preparation using standardized radiographic imaging.[10] To allow accurate superimposition of the pre- and postoperative images, the head of the X-ray tube was fitted to a cylinder-shaped apparatus so as to remain stationary and at a constant distance from the digital sensor used to acquire all of the images. The acrylic jig containing the root was then positioned at the center of the sensor so as to align perfectly with a square-shaped guide previously designed on the sensor, thus allowing the jig to be accurately repositioned during the experimental procedure.

Root canal instrumentation

The working length was established with a size 10 K file, using 5% sodium hypochlorite (Ogna; Muggiò, Milan, Italy) as irrigant, which was introduced into each canal until the file tip became visible at the major foramen under stereomicroscope (SOM 32; Karl Kaps GmbH & Co. KG, Asslar/Wetzlar, Germany) magnification. Subsequently, the file was withdrawn until the tip was tangential to the major foramen. The rubber stop was adjusted to the nearest flat anatomic landmark on the tooth, which was

Table 1 Characteristics of curved root canals ($n = 15$ teeth per group).

Group	Curvature (°)			Radius (mm)		
	Mean (SD)	Min	Max	Mean (SD)	Min	Max
WO	40.2 (3.39)	35	45	6.25 (1.17)	4.4	8.1
RE	40.6 (3.44)	35	45	6.21 (0.87)	4.2	7.5
OS	39.8 (3.76)	35	45	6.52 (1.11)	4.7	8.7
P	0.825			0.687		

OS = OneShape ; RE = Reciproc; WO = WaveOne.

Please cite this article in press as: D'Amario M, et al., Canal shaping of different single-file systems in curved root canals, Journal of Dental Sciences (2017), http://dx.doi.org/10.1016/j.jds.2017.03.001