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Ability of Different file Systems in Shaping Severely Curved Root Canals of Extracted Teeth- An in Vitro Study

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Abstract Original Research Article

Aim: To compare the shaping ability of three different file systems with rotary instruments during the preparation of curved root canals in extracted teeth. ***Materials and Methods:*** total of 60 root canals with curvatures ranging between 25° and 35° were divided into three groups of 20 canals. Based on radiographs taken prior to instrumentation, the groups were balanced with respect to the angle and the radius of canal curvature. Canals were prepared to the following apical sizes Reciproc, twisted file, and OneShape: Using pre- and post-instrumentation radiographs, straightening of the canal curvatures was determined with a computer image analysis programme. ***Results:*** The mean total width of the prepared canals in the Reciproc group was greater than the TF groups at halfway to the orifice, the beginning of the curve, the apex of the curve, and the end-point ($P < 0.05$). Mean absolute transportation was always <0.16 mm; however, significant differences occurred between the three systems at the orifice, halfway to the orifice, and the beginning of the curve ($P < 0.05$). ***Conclusions:*** Under the conditions of the study, Reciproc produced widest canal shapes. TF provided more centered apical preparation and maintained the original canal shape well.
Keywords: Canal Curvature, Canal Straightening, Oneshape, Reciprocal Motion.

INTRODUCTION

Various attempts have been made to further improve and facilitate mechanical root canal preparation with a comprehensive range of different engine-driven nickel–titanium (NiTi) instruments being available to achieve this goal [1]. Recently, two different concepts of single-file systems have been introduced. Reciproc (VDW, Munich, Germany) and Wave- One (Dentsply Maillefer, Ballaigues, Switzerland). These instruments are made of a special NiTi alloy called M-wire that is created by an innovative thermal-treatment process [2-4] and are used in a reciprocal motion .Another concept of single-file instrumentation is that a single instrument is to be used in a full clockwise rotation. OneShape (Micro Mega, Besancon, France) belongs to this group of single file systems. The OneShape system consists of only one instrument, which has a tip size of 25 and a constant taper of 0.05, and is characterized by different cross sectional designs over the entire length of the working part. This instrument is made of a conventional austenite 55- NiTi alloy. OneShape is used in a continuous clockwise rotation. As recommended by the manufacturers, the rotational speed for One Shape is 400 rpm. The use of torque-control motors or torque-limited rotation handpieces is recommended by both manufacturers. The torque setting should be 4 Ncm for One Shape. The Twisted file (TF; SybronEndo, Orange, CA, USA) is another NiTi rotary system, and three new design methods, such as R-phase heat treatment, twisting of the metal, and special surface conditioning are used during their manufacturing process [5]. This process significantly increases the instrument resistance to cyclic fatigue and flexibility [6]. TF is characterized by a triangular cross-section, variable pitch, and safe ended tip. The instruments are available in sizes from 25 to 50 with tapers of 0.04, 0.06, 0.08, 0.10, and 0.12. The recommended speed with torque setting is 500 rpm with 400 gcm for this system. Therefore the study was designed to compare the canal preparation by these file systems.

MATERIALS AND METHODS

A total of 60 extracted human teeth with at least one curved root and curved root canal were selected. Only teeth with intact root apices and whose

root canal width near the terminus was approximately compatible with size 15 were included. Standardized radiographs were taken prior to instrumentation with the initial root canal instrument of size 15 inserted into the curved canal. The degree and the radius of canal curvature were determined using a computerized digital image processing system [7]. Only teeth whose radii of curvature ranged between 2.5 and 10.1 mm and whose angles of curvature ranged between 25° and 35° were included. Coronal access was achieved using diamond burs, and the canals were controlled for apical patency with a root canal instrument of size 10. The working length was obtained by measuring the length of the initial instrument (size 10) at the major apical foramen minus 1 mm. teeth were randomly divided into three groups:

Group A

OneSpape file having a size 25 and a taper of 0.06 was used in a gentle in-and-out motion with a rotational speed of 400 rpm, and the torque was adjusted to 4 Ncm according to the manufacturer's instructions.

Group B

TF instruments were used with an endomotor (X Smart Plus Dentsply) according to manufacturer's instructions and root canal instrumentation commenced with coronal flaring using a size 0.08/25 file. A size 0.06/25 instrument was then inserted and used 2 mm short of the WL. Apical instrumentation to the WL was achieved using a size 0.04/25 instrument.

Group C

A Reciproc R25 (0.08/25) instrument was used with an endomotor in a reciprocating, slow, in-and-out pecking motion mode until reaching the WL according to the manufacturer's instructions. The flutes of the instrument were cleaned after three pecks. Postinstrumentation photographs of the canals were taken after canal preparation. A composite image was produced from the pre and postinstrumentation images of each canal and superimposed using Adobe Photoshop CS3 (Adobe System, San Jose, CA, USA). Measurements were made on superimposed images using Image J 1.42q computer program (National Institutes of Health, Bethesda, MD, USA) with an accuracy level of 0.001 mm. All root canal preparations were completed by one operator while the assessments of the canal curvatures prior to and after instrumentation were carried out by a second examiner who was blind in respect of all experimental groups

Statistical analysis

All statistical analyses were performed using SPSS software (SPSS Inc, Chicago, IL, USA). The normality of the data was confirmed by the Kolmogorov–Smirnov test and the groups were statistically compared using analysis of variance complemented by Tukey's test with a level of significance of $P < 0.05$.

Table-1: Mean total width (mm) of the canals at the

	Reciproc	Oneshape	TF	P
Orifice	0.949	0.861	0.960	0.001
Beginning of curve	0.657	0.568	0.489	0.001
Apex of curve	0.514	0.447	0.362	0.001
End-point	0.319	0.296	0.255	0.001

RESULTS

The mean total width of the prepared canals is shown in Table 1. The Reciproc group caused significantly greater widening of canals than the other two groups at halfway to the orifice, the beginning of the curve, the apex of the curve, and the end-point ($P < 0.05$). At the beginning of the curve, the apex of the curve, and the end-point the narrowest total width measurements were noted in the TF group ($P < 0.05$). Mean total width measurement was less with OneShape than with Reciproc and TF at the orifice ($P < 0.05$).At the beginning of the curve, the apex of the curve, and the end-point, least resin removed from the inner aspect of the curve with TF instruments ($P < 0.05$) [Table 2]. Reciproc instruments removed more dentin from the outer aspect of the curve compared with the OneShape and TF at halfway to the orifice, the beginning of the curve, the apex of the curve, and the end-point ($P < 0.05$). At the orifice, more dentin removed from the outer aspect of the curve with TF instruments ($P < 0.05$) [Table 2].

Table-2: Mean inner and outer width measurements (mm) of the canals at the different measuring points

	Orifice		Beginning of curve		Apex of curve		End-point	
	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer
Reciproc	0.219a	0.207a	0.195a	0.265a	0.135a	0.128a	0.057a	0.067a
Oneshape	0.160b	0.189a	0.139b	0.077b	0.109b	0.094b	0.040b	0.050b
Tf	0.183b	0.249b	0.158b	0.084b	0.050c	0.083b	0.028c	0.039b
P	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

DISCUSSION

The aim of this study was to assess and compare the shaping ability of the three single-file systems Reciproc, One Shape, and TF with the established full sequence rotary instruments in severely curved root canals of extracted human teeth. The teeth in all groups were balanced with respect to the apical diameter and the length (distance between apex and CEJ) of the root canal, and based on the initial radiograph, the teeth were also balanced with respect to the angle and the radius of canal curvature. The results for all instruments were comparable to those of recent investigations under similar experimental conditions [8-10]. The mean straightening ranged between 1.74° when using OneShape and 1.35° when using Reciproc, whereas the mean straightening for other rotary NiTi instruments under similar conditions was in the range of 1.24° and 3.22° [11]. However, when compared with the results of a recent study [10], the mean canal straightening for Reciproc and TF observed in the present investigation was lower. This is mainly due to the fact that in the present study, canals having curvatures between 25° and 35° were instrumented, whereas in the aforementioned study, this range was rather greater in as far as canals with curvatures between 25° and 39° were prepared. The dentin removal from the inner aspect of the curve was greater with Reciproc than with one shape and TF instruments at all measuring points ($P < 0.05$). At the beginning of the curve, the apex of the curve, and the end-point, least dentin removed from the inner aspect of the curve with TF instruments ($P < 0.05$) [Table 2]. This is in agreement with previous studies that showed that Reciproc instruments removed more dentin along the canal [12, 13]. Sharp double cutting edge S-shaped geometry, smaller cross-sectional area [14], and the dissimilarities between tapers of the master apical instruments may explain the greater cutting ability of Reciproc instruments. A recent study showed that 0.06 taper One Shape and TF Adaptive instruments removed less dentin than R25 instrument, but 0.06 taper Pro Taper Next instrument removed similar amounts of dentin compared with other instruments having a 0.08 apical taper[15]. In the present study, all three instruments produced minimal transportation (always <0.16 mm). Reciproc and One Shape instruments showed similar transportation at all measuring points. Despite the Reciproc and One Shape instruments having different features (alloy, kinematic, taper, and number of the files), their similar cross-section design may explain this result. The present finding is corroborated by recent studies that TF instruments caused less transportation than Reciproc and WaveOne instruments[16], Pro Taper instruments [17], and K3 instruments[25,26]. Furthermore, a recent study noted that Reciproc and TF instruments do not differ significantly in terms of canal centering ability and transportation [18]. Better shaping results of the TF instruments, which are manufactured by twisting, can be attributed to the fact that these instruments are more flexible than the other NiTi instruments, which are manufactured by grinding [17]. Furthermore, R-phase heat treatment and special surface conditioning of the alloy during manufacturing, which makes it more flexible.

CONCLUSIONS

Within the limitations of this study, Reciproc, one shape, and TF systems instrumented curved canals without creating zips, elbows, ledges, or perforations. Reciproc produced widest canal shapes and removed more dentin from the inner and outer aspect of the curve. TF provided more centered apical preparation and maintained the original shape of the curved canals well.

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