Comparison of root canal preparation using reciprocating Safesiders stainless steel and Vortex nickel-titanium instruments

S. Craig Rhodes, DMD,a Michael Hülsmann, DMD,d Sandre F. McNeal, MPH,b Preston Beck, BME, MS,c and Paul D. Eleazer, DDS, MS,e Birmingham, Alabama; and Göttingen, Germany
UNIVERSITY OF ALABAMA SCHOOL OF DENTISTRY AND UNIVERSITY OF GÖTTINGEN

Objective. The aim of the present study was to assess several parameters related to the clinical usage of 2 root canal preparation instruments: Vortex .06 rotary nickel-titanium instruments, and Safesiders reciprocating stainless steel instruments.

Study design. Fifty extracted mandibular molars with mesial root canal curvatures between 20° and 50° were divided into 2 groups and embedded in acrylic resin inside a modified Bramante muffle system. All root canals were prepared to ISO size 40 using either Vortex .06 rotary nickel-titanium-instruments in a low-torque motor or Safesiders stainless steel instruments in a proprietary reciprocating handpiece. The following parameters were evaluated: straightening of curved root canals, working safety issues (perforations, instrument breakages, canal blockages, loss of working length), postpreparation root canal cross-section, and working time.

Results. The Vortex .06 instruments maintained canal curvatures well, with the mean degree of straightening recorded as 0.72°. Safesiders instruments demonstrated significantly more canal straightening, with the mean degree of straightening recorded as 15.5°. More than 90% of the root canals prepared with the Vortex .06 instruments resulted in a round or oval cross-section, whereas the Safesiders instruments produced round or oval cross-sections 60% of the time. Neither of the 2 instruments could effectively prepare 100% of the root canal circumference. The area of dentin removed and the remaining dentin thicknesses from each region were similar for the 2 groups. Six procedural incidents were recorded for the Vortex .06 group, compared with 19 for the Safesiders group. There were no instrument fractures recorded in either group. Mean working time was significantly shorter for Vortex .06 (279 s) than for Safesiders (324 s).

Conclusions. Vortex .06 maintained the original root canal curvatures well, whereas Safesiders instruments demonstrated significant straightening and irregular preparation shapes when used in sizes larger than ISO 20. Preparation of the complete circumference of the root canal was not possible with either system. Fewer procedural errors occurred with the Vortex instruments. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:659-667)

The mechanical preparation of the root canal, accompanied by thorough chemical disinfection, is recognized as one of the most important steps in root canal treatment. The preparation of continuously tapering conical canal shapes while avoiding iatrogenic aberrations has been advocated as a desirable objective.1-3

In some teeth, the length, initial size, and especially degree and radius of the curvature of the canal can complicate the clinician’s ability to accomplish the desired shaping objectives. Weine et al.4 showed steel root canal instruments tend to straighten when placed into curved canals, leading to the development of an irregular apical shape showing elbows and zips. Several methods have been developed in an attempt to overcome the creation of these iatrogenic aberrations during instrumentation of curved canals. Weine et al.4 advocated precurving files and removal of the outer edge of flutes near the tip of selected instruments to minimize the zip. Buchanan5 advocated modification of traditional Hedström files made of stainless steel by grinding 1 side of the file to create a safe edge with a rounded tip. The machined
The flat edge was postulated to eliminate perforation of the inner aspect of canal curvatures by reducing the aggressive cutting action inherent in the unaltered file. The rounded noncutting tip was proposed to eliminate ledging. The instrument is marketed as a Safety Hedström file (Kerr Corp., Romulus, MI, USA).

The tip design of endodontic instruments has also been proved to affect canal preparation. Alteration of the traditional file tip through removal of cutting points creates a more parabolic shape which can potentially eliminate transportation of the canal and has been demonstrated to reduce both ledging and transportation compared with files with unmodified tips.

Inventive clinicians have tried to overcome these difficulties by using automated devices for preparation. The first was described in 1899 by Rollins, and since that time many such devices have been introduced into the dental marketplace. In particular, the Giromatic reciprocating handpiece has been advocated for use by its adherents as a safe and effective alternative to hand instrumentation. Several studies refute this recommendation and demonstrate the creation of canal aberrations and irregular shapes accompanying the use of these devices, especially when larger file sizes are used.

The introduction of nickel-titanium (Ni-Ti), a more flexible metal than stainless steel, to endodontics was proposed to address many of the shortcomings associated with the latter instruments. However, one of the problems associated with use of rotary Ni-Ti instruments has been the risk of file fracture.

Profile Vortex rotary endodontic instruments (Dentsply, Tulsa Dental Specialties, Tulsa, OK, USA) were introduced in 2009. The instruments have been described as having patented variable helical angles and are constructed from M-wire Ni-Ti, an alloy fabricated by a proprietary process of heating and cooling nickel-titanium wire under tension. The system is composed of 0.04 taper and 0.06 taper instruments in sizes ranging from ISO 10 to ISO 50. Each instrument is described as having an 11-mm handle, a safe-ended tip, and an active blade.

Recently, a manufacturer (Essential Dental Systems, South Hackensack, NJ, USA) has introduced a system for endodontic preparation and debridement that includes a modified reamer working in a reciprocating motion. Unlike the modified Hedström file design patented by Buchanan, this instrument was created by flattening the entire side of a traditional stainless steel K-reamer, extending the machined flat to the central axis of the instrument and carrying it along the entire length of the cutting flutes. The instrument, marketed as the Safesiders instrumentation system, is described as having a cutting tip and is advocated for use with a reciprocating handpiece marketed as the Endo-Express. The system is composed of: 1) a modified #2 Peeso reamer, termed the Pleezer, which has a tip size of 0.75 mm with .03 taper; and 2) 2 stainless steel reamers in .02 taper (ISO 08 and 10), 6 stainless steel modified reamers in .02 taper (ISO 15-40), and 3 Ni-Ti modified reamers (ISO 30/.04 taper, ISO 25/.06 taper, and ISO 25/.08 taper). This instrumentation system has been purported to overcome the main drawback to rotary Ni-Ti file systems, that of file breakage, while at the same time producing canal shapes superior to those produced by rotary Ni-Ti files.

The aim of the present study was to compare several parameters of preparation of curved canals using Vortex .06 Ni-Ti and Safesiders stainless steel instruments. Canal straightening in the coronal, middle, and apical segments of curved canals, remaining dentin thickness on the furcation side of lower first molars, working time, and safety issues were recorded and compared.

**MATERIALS AND METHODS**

**Preparation of teeth**

The Bramante technique has been used for many similar shaping comparison studies to reliably compare root canal anatomy before and after instrumentation. This method has been modified and improved upon over time by several different investigators. The Göttingen experimental design is a more recent modification of, and an improvement upon, the original Bramante muffle block description and was chosen for use in the present study.

A brass muffle-block was used, consisting of a U-shaped middle section, and 2 lateral walls which were fixed together with 3 thumb screws. Grooves and recesses milled into the walls of the 3 sections allowed removal and exact repositioning of the complete tooth-acrylic block or the sectioned parts of the tooth in acrylic (Fig. 1). A modification of a radiographic platform as described by Southard et al. and Sydney et al. could be affixed to the outside walls of the muffle (Fig. 2). This afforded the consistent exposure of radiographs under standardized conditions and geometric relationship to allow accurate superimposition of views taken before, during, and after root canal preparation. Orthodontic acrylic was used to cold-cure 2 metallic reference objects into recesses created in the film holder which when aligned, allowed for an exact superimposition of the radiographs. The system and the evaluation technique have been previously described in detail.

Fifty extracted mandibular molars with intact roots and apices and 2 curved mesial root canals with separate foramina were accessed, and apical patency was established using an ISO 10 reamer. The reamer was
inserted until the tip could just be seen exiting the apical foramen. All teeth were subsequently shortened to a length of 19 mm, thus establishing the working length in the mesial canals at 18 mm. A small ball of red wax was affixed to the apex of each mesial root before mounting the tooth into the muffle-block using acrylic resin. The teeth were then isolated with rubber dam and a clamp to simulate clinical procedures. Individual curvatures and the radius of curvature of the mesial root canals were measured according to the method of Schneider28 after inserting an ISO 15 reamer to the working length. The teeth were divided into 2 groups. A similar mean degree of root canal curvature was achieved by exchanging a few of the teeth between the groups.

Twenty-five teeth with 50 mesial root canals were prepared with the Vortex .06 file system, and the other 25 teeth with 50 canals were prepared with the Safesiders instrument system.

**Instruments and preparation techniques**

**Vortex.** The sequence of Vortex .06-tapered Ni-Ti instruments used in the present study was as suggested by the manufacturer. Root canal preparation was performed in a crown-down sequence as follows: Vortex .06 size 25, 14 mm; size 30, 14 mm; size 20, 16 mm; size 15, working length (18 mm); and sizes 20-40, working length (18 mm). The total number of instruments used was 9.

All instruments were used in a low-torque motor (AEU-20; Aseptico, Woodinville, WA, USA), utilizing torque control, at a constant speed of 500 rpm and torque values set between 195 and 368 g/cm.

**Safesiders.** Root canal preparation with the Safesiders instruments was performed as recommended by the manufacturer: Safesiders stainless steel .02 sizes 08-20 in sequence, working length + 0.5 mm (18.5 mm); Pleezer reamer to within 6 mm of apex or approximately half the length of the canal as measured from orifice to apex; Safesiders stainless steel 0.02 size 25, working length + 0.5 mm (18.5 mm); Safesiders stainless steel .02 size 30, working length (18 mm); Safesiders Ni-Ti .04 size 30, working length (18 mm); Safesiders stainless steel .02 size 35, working length (18 mm); Safesiders stainless steel .02 size 40, 17 mm; Safesiders Ni-Ti .06 size 25, working length + 0.5 mm (18.5 mm). The total number of instruments used was 11.

All instruments were used in the proprietary Endo-Express reciprocating handpiece (Essential Dental Systems, South Hackensack, NJ, USA), described as a “¼-turn, ¼-speed reduction, ISO E-type coupling, push-button endodontic handpiece for hand instrument”. The motor used was the Endo-Express, an E-type, 4-hole air motor. It was operated at 10,000 rpm between 40 and 50 psi.

In both groups, irrigation was performed with 2 mL sodium hypochlorite (5.25%) after each instrument size exchange. RC Prep (Premier Dental, Plymouth Meeting, PA, USA) was used as a chelating and lubricating
agent with each instrument. Instruments were discarded after the preparation of 5 root canals.

Evaluation of preparation

Initially, the mesiobuccal root was instrumented in the unsectioned teeth. Parameters studied were canal straightening (transportation), perforation, apical blockage, working time, and instrument fracture. Before canal preparation, a radiograph with an ISO size 15 instrument was made and measurement of the initial root canal curvature done by using an established technique.28 After preparation to ISO size 20, 30, and 40, radiographs were again made with the corresponding files in the canals. The radiographs were scanned and saved as JPEG files. With the software program Thumbs Plus (Cerious Software, Charlotte, NC, USA) the scanned radiographs were enlarged to 8×, inverted, and printed on transparent film. The reference objects embedded in the radiographic film holder allowed for the exact superimposition of the pre- and postinstrumentation radiographs. The amount of change in canal angulation was determined by measurement of the angle between the tips of the shaping instruments projected onto the transparent films and measured with a standard protractor.

The teeth, embedded in their acrylic blocks, were separated from the muffle-block and sectioned horizontally at 3, 6, and 9 mm from their respective apices using an Isomet low-speed saw (Buehler, Lake Bluff, IL, USA) with a diamond disk (Lapcraft, Powell, OH, USA) thickness measuring 0.5 mm.

The pretreatment horizontal sections of the mesiolingual canals were photographed under standardized conditions with 15× magnification, and the teeth sections were reassembled and inserted back into the muffle-block, using the horizontal grooves that had been made in the block as guides. The mesiolingual canals were then prepared exactly as the mesiobuccal canals had been. The same parameters were measured as before, including the comparison of the transparency films to record changes in canal angulation. The sections were then removed from the muffle-block and the mesiolingual canals again photographed in the same manner as before. The postoperative cross-sections were then classified as being round, oval, or irregular in form by using an established method.29 Per that method, irregular forms were considered to be unacceptable preparations. The following parameters were measured using the software program Scion Image (Scion Corp., Frederick, MD, USA): amount of dentin (area) removed and minimum remaining furcal dentin/cementum thickness as calculated using an earlier method.30 The remaining dentin/cementum thickness data were used to calculate the percentages of remain-

| Table I. Analysis of root canal straightening (in degrees) |
|-------------|------------------|
|             | Vortex           | Safesiders       |
|             | Unsectioned      | Sectioned roots  | Unsectioned | Sectioned roots |
| n           | 25               | 25               | 25          | 25              |
| Mean preoperative curvature Straightening |                           |
| Min         | 0                | 0                | 0           | 0               |
| Max         | 3                | 3                | 25          | 22              |
| Mean        | 0.72             | 0.72             | 16.6        | 14.5            |

Statistical analyses

Statistical tests used for canal straightening and working time were 2-way analysis of variance (ANOVA) (P < .05) for regression analysis (means and standard deviations were obtained). Student’s t test and chi-square analysis for comparison of the remaining dentin/cementum thickness (P < .05); and Fisher’s exact test for comparison of the canal cross-sections (P < .05). All analyses were done using SAS 9.2 (SAS Institute, Cary, NC, USA) and SPSS (SPSS 19; SPSS Inc., Chicago, IL, USA). The level of significance was set as P < .05.

RESULTS

Distribution of preoperative root canal curvatures

The mean preoperative root canal curvatures were 26.9° in the Vortex .06 rotary group (n = 25 teeth) and 22.6° in the Safesiders reciprocating group (n = 25 teeth). The mean preoperative root canal radii of curvature were 7.6 mm in the Vortex .06 rotary group and 7.9 mm in the Safesiders reciprocating group.

Straightening

After preparation to ISO size 40, the mean canal straightening was 0.72° in the Vortex .06 rotary group (n = 50 root canals) and 15.5° in the Safesiders reciprocating group (n = 50). The difference was statistically significant (P < .0001; ANOVA) (Table I).
Upon further analysis of the data, it was determined that the Vortex .06 instruments did not cause any significant degree of canal straightening when moving from the smallest instrument (ISO 15) to the largest (ISO 40) ($P/H11022 < .05$; ANOVA). In comparison, the Safesiders instruments appeared to effect minimal transportation only up to ISO 20 ($P/H11022 < .05$; ANOVA). Beyond the ISO 20 size (ISO 25-40) significant canal straightening occurred ($P/H11021 < .0001$; ANOVA). The degree of canal straightening was directly related to the degree of canal curvature.

**Working time**

The mean working time measured when the unsectioned roots were prepared was 279 seconds for the Vortex .06 rotary group (9 instruments) and 324 seconds for the Safesiders reciprocating instruments (11 instruments). The difference was statistically significant ($P < .0001$; ANOVA).

**Remaining dentin/cementum thickness**

The mean values of the least remaining furcation-side dentin/cementum root thicknesses at the 3 root levels measured before and after instrumentation, as well as the percentage of remaining root thickness, are presented in Tables II and III. There were no statistically significant differences between the 2 groups ($P > .05$; Student’s t test).

Regarding the distribution of remaining dentin/cementum root thickness from the 3 measured levels in the mesial roots, Table IV compares the 2 groups. Once again, there were no statistically significant differences notable between the 2 groups ($P > .05$; chi-square).

**Procedural errors**

No file fractures occurred with either group of instruments. The Vortex .06 group produced 3 specimens with loss of working length and 2 apical blockages. In the Safesiders group, 7 specimens with loss of working length and 9 apical blockages resulted. The loss of working length for both systems was found to be $\leq 1$ mm. Furcation-side root perforations occurred as follows: 1 in the Vortex .06 group (at 9 mm from the apex, i.e., in the coronal portion of the root) and 3 in the Safesiders group (1 at 9 mm from the apex and 2 at 6 mm from the apex, i.e., the curved portion of the root). The total number of procedural errors was 6 in the Vortex .06 group and 19 in the Safesiders group.

### Table II. Results of Vortex .06 instruments ($n = 25$)

<table>
<thead>
<tr>
<th>Level, coronal to apex (mm)</th>
<th>Least dentin/cementum thickness from canal to root surface (mm)</th>
<th>Tooth structure removed</th>
<th>Final dentin/cementum as % of original</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preinstrumentation (mean $\pm$ SD; $\mu_1$)</td>
<td>Postinstrumentation (mean $\pm$ SD; $\mu_2$)</td>
<td>($\mu_1 - \mu_2$)</td>
</tr>
<tr>
<td>9.0</td>
<td>1.23 $\pm$ 0.32</td>
<td>0.77 $\pm$ 0.37</td>
<td>0.46</td>
</tr>
<tr>
<td>6.0</td>
<td>1.17 $\pm$ 0.35</td>
<td>0.76 $\pm$ 0.28</td>
<td>0.41</td>
</tr>
<tr>
<td>3.0</td>
<td>1.04 $\pm$ 0.47</td>
<td>0.88 $\pm$ 0.41</td>
<td>0.12</td>
</tr>
</tbody>
</table>

### Table III. Results of Safesiders instruments ($n = 25$)

<table>
<thead>
<tr>
<th>Level, coronal to apex (mm)</th>
<th>Least dentin/cementum thickness from canal to root surface (mm)</th>
<th>Tooth structure removed</th>
<th>Final dentin/cementum as % of original</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preinstrumentation (mean $\pm$ SD; $\mu_1$)</td>
<td>Postinstrumentation (mean $\pm$ SD; $\mu_2$)</td>
<td>($\mu_1 - \mu_2$)</td>
</tr>
<tr>
<td>9.0</td>
<td>1.31 $\pm$ 0.28</td>
<td>0.89 $\pm$ 0.41</td>
<td>0.42</td>
</tr>
<tr>
<td>6.0</td>
<td>1.20 $\pm$ 0.27</td>
<td>0.73 $\pm$ 0.42</td>
<td>0.46</td>
</tr>
<tr>
<td>3.0</td>
<td>1.14 $\pm$ 0.23</td>
<td>0.91 $\pm$ 0.32</td>
<td>0.22</td>
</tr>
</tbody>
</table>

### Table IV. Frequency distribution of postinstrumentation dentin/cementum thicknesses

<table>
<thead>
<tr>
<th>Group</th>
<th>Postinstrumentation thickness of dentin/cementum (mm)</th>
<th>Perforations</th>
<th>Sections with $&lt;0.5$ mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&gt;0.5$</td>
<td>$&lt;0.5$</td>
<td>$&lt;0.4$</td>
</tr>
<tr>
<td>Vortex .06 (n = 75)</td>
<td>64</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Safesiders (n = 75)</td>
<td>63</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Table V. Evaluation of postoperative root canal shapes

<table>
<thead>
<tr>
<th>Section</th>
<th>Vortex .06 Acceptable</th>
<th>Safesiders Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal Round</td>
<td>18 23 (92%)</td>
<td>7 17 (68%)</td>
</tr>
<tr>
<td>Oval</td>
<td>5 10</td>
<td></td>
</tr>
<tr>
<td>Irregular</td>
<td>2 8</td>
<td></td>
</tr>
<tr>
<td>Curve Round</td>
<td>14 22 (88%)</td>
<td>8 15 (60%)</td>
</tr>
<tr>
<td>Oval</td>
<td>8 7</td>
<td></td>
</tr>
<tr>
<td>Irregular</td>
<td>3 10</td>
<td></td>
</tr>
<tr>
<td>Apical Round</td>
<td>16 23 (92%)</td>
<td>8 13 (52%)</td>
</tr>
<tr>
<td>Oval</td>
<td>7 5</td>
<td></td>
</tr>
<tr>
<td>Irregular</td>
<td>2 12</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>75 75</td>
<td></td>
</tr>
</tbody>
</table>

Cross-sections

Table V provides a summary of the postoperative cross-sections. In all 3 regions of the root canal, the overall number of acceptable canal shapes produced by the Vortex .06 instruments was greater than those produced by the Safesiders group. The results were statistically significant ($P < .05$; Fisher’s exact test).

DISCUSSION

The present study aimed at an evaluation of the clinical usefulness of 2 mechanically aided endodontic instruments. Root canal straightening, procedural errors, working time, and remaining dentin thickness were studied using a recent modification of the original Bramante muffle-block device. Instrument shaping studies such as this one are typically conducted using either plastic resin blocks or extracted teeth. Each method has its own advantages and disadvantages. Resin blocks afford standardization of the degree and radius of simulated canal curvature but their use has been criticized as not being an accurate replacement for natural tooth structure, especially considering the effect of generated heat on resin softening. The use of extracted teeth more closely reproduces the hardness, multiplanar canal shapes, and clinical conditions found in vivo and affords some degree of standardization, despite the differing individual canal morphologies. Instead of using radiographs for evaluation of shaping abilities the use of microscopic computerized tomography has been proposed by Peters et al., which allows nondestructive and 3-dimensional evaluation of root canal anatomy and its alterations.

Canal straightening

The outcome of the present study considering the Vortex .06 instruments confirms the results of many earlier studies which demonstrated the superior ability of rotary Ni-Ti preparations to maintain root canal curvatures, even when the curvatures are quite severe. The mean overall result for canal straightening of 0.72° can be regarded as an acceptable clinical outcome with minimal aberrant alteration of the originally curved canal shapes.

Several studies have also looked at the use of reciprocating stainless steel files for root canal preparation and have found preparations that deviated significantly from the original canal shapes. The 15.5° of overall canal straightening resulting from the use of the stainless steel Safesiders instruments in the present study confirms many earlier studies. The observed degree of canal straightening was minimal up to an ISO size 20 but then increased significantly when using the ISO 25-40 instruments.

The machined flat surface (Figs. 3 and 4) created on one side of the Safesiders instruments could be consid-
ered to improve their flexibility over that of the traditional stainless steel K-reamers from which they are derived. However, based on the results of the present study, this patented modification does not appear to increase the instrument’s flexibility and reduce the degree of straightening under our simulated clinical conditions.

The cutting tip of the Safesiders instrument appears unique in design. The scanning electron microscope images reveal that the extension of a machined flat surface the full length of the reamer flutes to the tip creates additional potential cutting surfaces not typically present in traditional K-reamers (Figs. 3, 4, and 5).

The increased rigidity of the larger-sized stainless steel instruments as they attempt to straighten in curved canals, coupled with the aggressive effects of this unique cutting tip could explain the relatively high degree of canal straightening found in the present study.

The recommendation that automated (including reciprocating) canal preparation with stainless steel instruments should be confined to small instrument sizes not exceeding ISO 2540 is supported by our results.

**Working time**

In the present study, the time required for canal preparation in extracted teeth included active instrumentation time, irrigation time, and time for instrument exchanges.

The finding that Vortex .06 rotary instruments took significantly less time for canal preparation than Safesiders instruments might be partially explained by the fewer number of instruments involved in the Vortex .06 protocol (9 vs. 11 instruments). In another study on working time, the authors determined that the Safesiders instruments required less working time than conventional files and reamers. However, that study was also influenced by the fact that the Safesiders protocol used 2 fewer instruments than the protocols of other groups being studied. That difference alone could account for the shorter working time.

The time difference found between the 2 groups in the present study was significant, and a relatively inexperienced clinician might attempt to save additional procedure time by exerting excessive pressure on the handpiece. This savings in time could result in increased canal straightening and iatrogenic mishaps.

**Procedural errors**

In accordance with earlier studies, no instrument fractures were reported in either group in the present study. The absence of fractures found within the Vortex .06 group might be partly explained by the unique properties of the alloy used to fabricate the instruments. One recent study found Profile 25/04 files fabricated from M-wire Ni-Ti to have significantly greater resistance to cyclic fatigue while maintaining comparable torsional properties to the other Ni-Ti alloys studied. Some loss of working length (range 0.5-1.0 mm) and apical blockages were observed. The greater amount of apical blockages seen in the Safesiders group could not be convincingly explained but may be related to increased debris packing from the use of reciprocating instruments or to the greater degree of canal straightening seen with this system.

**Cross-sections**

Comparisons of the preoperative and postoperative photographs of the root canal cross-sections allows for an evaluation and comparison of each system’s shaping ability. A critical property of any such endodontic instrument is its ability to effectively shape all areas of the canal, leaving no unprepared areas behind where microorganisms can remain. Although the majority of the canals appeared to be cleaned well, none of the instruments used in the present study were able to debride all aspects of every canal in which they were used 100% of the time. This is in accordance with the results of recent studies demonstrating that >30% of the root canal remains unprepared.

If the ideal shape of a prepared canal to allow complete obturation is a round tapering funnel which has the same cross sectional shape as the gutta-percha cone used to obturate it, then the evaluation of the canal cross-sectional shapes of prepared canals can provide worthwhile information regarding the efficacy of proposed instrument systems toward achieving that goal.
Because oval shapes can be created if the plane of sectioning is oblique to the central canal axis, we included both round and oval preparation shapes as being clinically acceptable. Irregular shapes were deemed to be clinically unacceptable.

The Vortex .06 system produced acceptable preparation canal shapes an average of 90.7% of the time, whereas the Safesiders system produced acceptable preparation shapes an average of 60% of the time. The curved and apical portions of the canals were the locations where increased numbers of irregular preparation shapes were created.

The greater number of unacceptable canal shapes created in the Safesiders group is most likely a consequence of the use of mechanical reciprocation, because other studies have recorded preparations which lacked uniformity, flow, and taper and demonstrated irregular shapes, especially in the apical third.11-13,35 The area of dentin removed during the preparation of the canals was similar in all 3 regions studied, and there was no significant differences found between the 2 groups.

CONCLUSIONS

The results of the present study confirm the outcomes of earlier studies on both the ability of Ni-Ti rotary systems to safely and effectively maintain root canal curvatures and the inability of reciprocating stainless steel instruments to prevent the creation of aberrant canal shapes. Neither of the 2 systems were able to prepare 100% of the area inside the existing canals. The Vortex .06 instrument system can be recommended for clinical use, but the problems encountered with the Safesiders reciprocating instruments suggest limiting them to instrument sizes smaller than ISO 25.

REFERENCES


Reprint requests:
S. Craig Rhodes, DMD
PO Box 290701
Port Orange, FL 32129
scraigrhodesdmd@gmail.com