A comparative study of Endoflare–Hero Shaper and Mtwo NiTi instruments in the preparation of curved root canals

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Abstract

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Aim To analyse the shaping ability of two new NiTi rotary systems in molar curved canals.

Methodology Thirty molar root canals with curvatures from 24° to 69° were divided into two groups that were balanced in terms of curvature. The canals in one group were shaped using the Mtwo (Sweden & Martina, Padova, Italy) and the canals in the other group using the Endoflare–Hero Shaper (Micro-Mega, Besançon, France) in a modified sequence. Pre- and post-instrumentation X-rays were taken using a radiographic platform, with a contrast medium being used to enhance canal opacity. The dentine removed at five positions along the canals, the symmetry of canal shaping and the presence of aberrations were analysed through computer-aided measurements. The instrument failures, the working time and the changes in working length were also recorded. The Mann–Whitney *U*-test was used for statistical analyses.

Results Both systems produced uniform dentine removal and symmetrical canal shapes; there was no significant difference between the systems ($P > 0.05$). In the apical region, preparations were centred in the canal. A mean loss of working length of 0.55 mm for Mtwo and 0.58 mm for Endoflare–Hero Shaper was detected, with no significant differences between the instruments ($P > 0.05$). No aberrations were seen and no instruments separated. The mean working time was 124.4 s for the Mtwo system and 141.3 s for the Endoflare–Hero Shaper but this difference was not statistically significant ($P > 0.05$).

Conclusion The systems tested in this study were effective in shaping curved canals in extracted teeth.

Keywords: curved canals, NiTi, root canal treatment.

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Introduction

The introduction of NiTi rotary instruments has led to great improvements in the effectiveness and the speed of root canal instrumentation even in curved roots (Bergmans *et al.* 2001). In order to achieve the mechanical goal of instrumentation that requires a uniformly tapered funnel preparation with increasing diameters from the end-point to the orifice, (Schilder 1974) several NiTi systems can be used. A number of studies, on both extracted teeth and simulated canals, have demonstrated that the NiTi rotary instruments allow more rapid (Glosson *et al.* 1995, Gambill *et al.* 1996, Schäfer & Lohmann 2002), more centred (Glosson *et al.* 1995, Gambill *et al.* 1996, Bertrand *et al.* 2001), rounder (Glosson *et al.* 1995, Gambill *et al.* 1996) and more conservative (Glosson *et al.* 1995, Gambill *et al.* 1996, Schäfer & Lohmann 2002) canal shaping than stainless steel instruments. However, despite these positive results, manufacturers continue to introduce NiTi systems with new blade designs and tapers, claiming increased safety and ease of use.

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The NiTi rotary instruments currently on the market vary considerably in their design (Bergmans *et al.* 2001). The blade designs are usually grouped in two categories: active cutting angle or radial landed design. Instruments included in the first category have sharp blades projecting from the middle of the shaft; on the contrary, radial landed blades have a flat surface at the blade margin.

Instruments also differ in their cross-sections, which affect the contact area with the canal walls and the amount of the residual core of the instrument (Ruddle 2001). When a positive blade rake angle is present, the cutting action is enhanced (Bergmans *et al.* 2001) and the torsional load of the instruments is decreased (Blum *et al.* 1999). The minimal amount of the residual core improves the flexibility of the instruments and, consequently, it is possible to increase the taper of the NiTi instruments (Ruddle 2001).

Another parameter that can be altered is the helical angle and the blade pitch. By balancing these two parameters along the blade length, the cutting action and the ability to remove debris from the blades and prevent screwing can be adjusted (Ruddle 2001).

Finally, the majority of the instruments have guiding tips that should follow the canal curvature (Bergmans *et al.* 2001).

Other differences between NiTi systems can be seen in their tapers. The instruments with increased taper have advantages because they shape the canal in its final conical outline more easily than the cylindrical instruments. Furthermore, when a system features instruments with different tapers, each of them engages a smaller portion of the canal with less torsional load and consequently reduces failure risk. Even though all the systems feature increased tapers, many variations in taper and instrument sequences are proposed.

The Mtwo (Sweden & Martina, Padova, Italy) and the Endoflare–Hero Shaper (Micro-Mega, Besançon, France) have been marketed recently and, to date, their canal shaping ability have not been investigated.

The Mtwo instruments have two blades and feature a large groove between them (Fig. 1). This design is claimed to reduce the core diameter and increase the flexibility. It is anticipated that the resistance of the instrument could not be affected because of the reduced contact against the canal walls, while the cutting action should be ensured by the active sharp angle of the blades. The blade angle is almost vertical and the helical pitch increases from the tip to the handle. These features are claimed to reduce the tendency for debris accumulation and to obtain an effective cutting action with less separation risks. Furthermore, the increasing pitch should allow a more delicate cutting action at the apex and a more aggressive one in the coronal portion. The Mtwo is available in the sizes 10, .04 taper, 15, .05 taper, 20, .06 taper, 25, .06 taper, 25, .07 taper, 30, .05 taper, 35, .04 taper and 40, .04 taper.

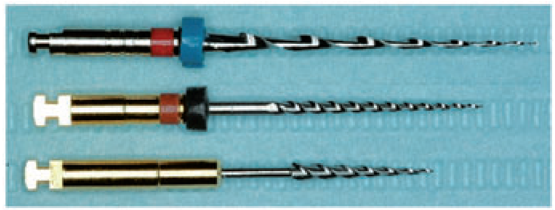

Figure 1 From below: the Endoflare, a Hero Shaper size 25, .06 taper and a Mtwo size 25, .06 taper.

The Hero Shaper is a new system that supplements the existing Hero 642 (Fig. 1). They both have the same triple helix cross-section but the helix pitch and the helix angle have been modified, while the handle has been shortened for improved access. The Hero Shaper helix angle increases from the tip to the shank that is claimed to reduce threading, while the pitch varies according to the taper and it is claimed to increase the efficiency, the flexibility and the strength of the instruments. The Hero Shaper files are supplied in the ISO sizes of 20, 25 and 30, and in 0.4 and 0.6 tapers. The Endoflare is a separate instrument that can be used in combination with other systems to aid instrumentation (Fig. 1). It has the same blade design as the Hero 642, a 25 size, a 0.12 taper, a blade length of 10 mm and it is used only to flare the coronal third at the beginning of shaping.

The aim of the study was to test, in curved canals, the shaping ability of these two new systems and to verify the viability of a modified working sequence for the Hero Shaper system, so that the larger and more tapered files were used first to free the progression to the apex of the smaller instruments.

Materials and methods

A total of 59 curved mandibular molars extracted for periodontal reasons were used. They were stored in physiological solution and used within 1 month following extraction. An access cavity was prepared in all teeth using a round diamond bur and an Endo-Z bur (Dentsply Maillefer, Ballaigues, Switzerland) on a high-speed handpiece. The crowns were shortened so that the teeth had the same working length of 19 mm.

Radiographs were exposed with a number 8 K-file (Dentsply Maillefer) placed in one mesial canal. Canal curvatures were measured on these radiographs according to Weine's (1982) method and 30 canals with curvatures ranging from 24° to 69° were selected. The specimens were divided to create two groups as balanced as possible in terms of canal curvatures. Each group included 15 canals. The mean curvature of the two groups was similar (group 1 – mean curvature: 40.6° ± 10.5°, median: 38°; group 2 – mean curvature: 39.7° ± 7.3°, median, 36°).

The first group was instrumented with Mtwo, and the second one with Endoflare–Hero Shaper. Each instrument was used to enlarge up to five canals, and was replaced if it failed before. Three sets of each kind of instruments were used.

Preparations were completed by an operator with 12 years of experience in endodontics. An ATR Teknica (Dentsply Maillefer) endodontic engine was used and the speed was adjusted to 320 rpm for Hero Shaper and 300 rpm for Mtwo, according to the manufacturer's instructions. The torque was set to 80 N cm. A chelating agent (Glyde File Prep; Dentsply Maillefer) and NaOCl 2.5% were used to fill the pulp chamber at the beginning of instrumentation. In addition, 2 mL of NaOCl was delivered in the pulp chamber after the use of each file.

Canal preparation

Group 1 was shaped using Mtwo instruments. The sequence proposed by the manufacturer and used for this study was the following:

- creation of a guiding path feeding a 10 manual K-file to the working length,
- the instrument sequence: 10, .04 taper, 15, .05 taper, 20, .06 taper, 25, .06 taper, 30, .05 taper and 35, .04 taper to the working length.

In one case, the initial 10 and 15 K-files were loose at the working length and so mechanical preparation began with the 15, .05 taper instrument.

The Mtwo sequence allows a gradual enlargement of the whole canal length. However, if the apical progression becomes difficult and binding of the blades within dentine is noted, the manufacturer suggests the instrument be withdrawn several millimetres and to enlarge the preparation with a brushing action against the coronal canal walls opposite to the furcation. This action is possible with the first three instrument of the sequence and it is claimed to provide the instrument with more space to continue the apical progression.

Group 2 was instrumented with the Hero Shaper system in combination with the Endoflare.

The working sequence, proposed by the manufacturer, is based on the degree of canal curvature but in this study it was modified as follows:

- creation of a guiding path feeding a size 10 manual file to the working length,
- the Endoflare was introduced 3 mm into the canal to eliminate the coronal interference as recommended by the manufacturer,
- instruments 30, .06 taper, 25, .06 taper and 20, .06 taper in sequence until the last one approached within 1–2 mm of the working length or possibly to the working length,
- use in sequence of the instruments 30, .04 taper, 25, .04 taper and 20, .04 taper until the 30, .04 taper approached the working length,
- Hero 642 35, .02 taper to the working length.

The sequence used was more closely adapted to the crown-down approach. The modification allowed the larger and more tapered files to be used in the coronal and the middle thirds of the canal.

All the instruments were used with a light in-and-out pecking motion until resistance was felt, in this case the smaller instrument in the series was used, and then the sequence was repeated.

It has to be noted that not all the instruments were required to complete the preparation. In two cases, after the use of .06 tapers, the instruments 25, .04 taper and 20, .04 taper were not used, as they did not meet any resistance because the instrument 30, .04 taper had already reached the working length. In the majority of cases, after the use of .06 tapers, the instrument 25, .04 taper could easily reach the working length; similarly, in these cases the smallest 20, .04 taper was not necessary.

Assessment of canal instrumentation

Data on instrumentation time included the amount of time the instruments were used in canal shaping, excluding that used for changing instruments and rinsing the canal.

To measure the amount of dentine removal and the canal symmetry, a contrast medium was injected into the canals to enhance opacity, then pre- and post-instrumentation radiographs were superimposed and evaluated according to previously described method (Veltri *et al.* 2004). In brief, a radiographic platform was used to expose standardized radiographs that were digitized afterwards. All the measurements were made using the software Scion Image (Scion Corp., Frederick, MD, USA). Dentine removal was measured at five reference points established on each canal median axis, using a method described by Calberson *et al.* (2002):

- point 1: the canal orifice (O),
- point 2: the point half-way from the beginning of the curve to the orifice (HO),
- point 3: the point where the canal deviates from the long axis of its coronal portion and is called the beginning of the curvature (BC),
- point 4: the point where the long axes of the coronal and the apical portions of the canal intersect and is called the apex of the curve (AC),
- point 5: the point where the preparation ends (EP).

The measurements were carried out at each of the five points on both the inner and the outer side of the curvature. All measurements were made perpendicular to the axis of the pre-instrumentation canal (Fig. 2).

The symmetry of preparation (expressed as an absolute value) was assessed by subtracting the amount of the dentine removed on the inner side from that of the dentine removed on the outer side, in accordance with a method introduced by Nagy *et al.* (1997).

Parameters used to evaluate the working safety were: the loss of working length, the fractured instruments and the canal aberrations. Variations of working distance were established by subtracting the preoperative from the postoperative length, while the number of separated instruments was recorded during instrumentation. Blockages of the instruments, due to the intrablade debris accumulation or to excessive friction against canal walls, were recorded. The presence of canal aberrations as defined by Bishop & Dummer (1997) was assessed on the images of superimposed canals. A zip was an irregularly widened area contiguous with the apical foramen. An elbow was present where the canal width, in the apical region, was greater than the coronal width to that point. A ledge was a deviation from the original curvature where a new canal path was created or was beginning to form.

The Mann–Whitney *U*-test was used to identify any significant difference between the two groups.

Results

Preparation time

The mean time needed for canal instrumentation was 124.4 s for the Mtwo system and 141.3 s for the Endoflare–Hero Shaper; there was no significant difference between the two techniques.

Canal form

The mean amount of dentine removal on the outer and on the inner side of the curvature is shown in Table 1. Mean canal widths after the instrumentation were regular at all the reference points along the canal curvature and no significant differences were found between the two systems.

Mean values for the preparation symmetry are presented in Fig. 3. At the apical level (EP), the preparation was almost perfectly centred in the canal and the canal transportation values were low at all the measurement points. No significant differences were found between the symmetry values of the two groups.

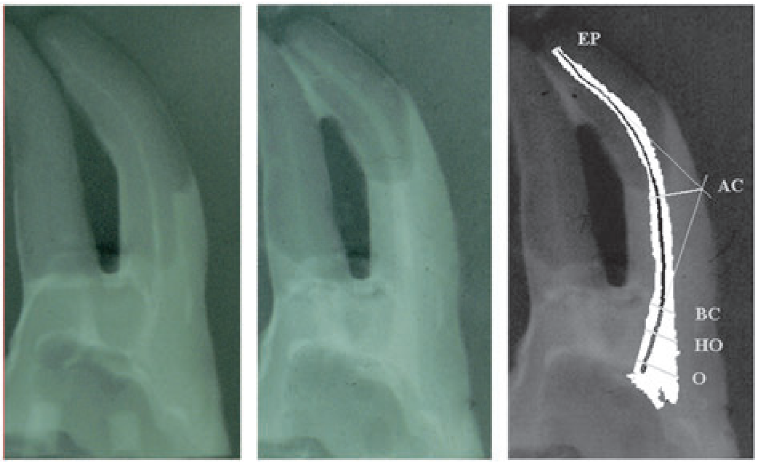

Figure 2 From left: the pre- and post-instrumentation X-rays and the superimposed image with the measurement points (O, orifice; HO, half-way orifice; BC, beginning of curvature; AC, apex of curvature; EP, end of preparation).

Table 1 Mean dentin removal at the measurement points along the canal

mm	O	HO	BC	AC	EP
Inner canal wall					
Mtwo	0.173	0.168	0.138	0.118	0.047
SD	0.012	0.014	0.01	0.013	0.2
Endoflare–Hero Shaper	0.17	0.128	0.12	0.1	0.06
SD	0.02	0.025	0.018	0.01	0.012
P-value	>0.05	>0.05	>0.05	>0.05	>0.05
Outer canal wall					
Mtwo	0.19	0.18	0.147	0.128	0.058
SD	0.018	0.02	0.017	0.014	0.009
Endoflare–Hero Shaper	0.212	0.168	0.15	0.122	0.057
SD	0.009	0.034	0.037	0.039	0.0016
P-value	>0.05	>0.05	>0.05	>0.05	>0.05

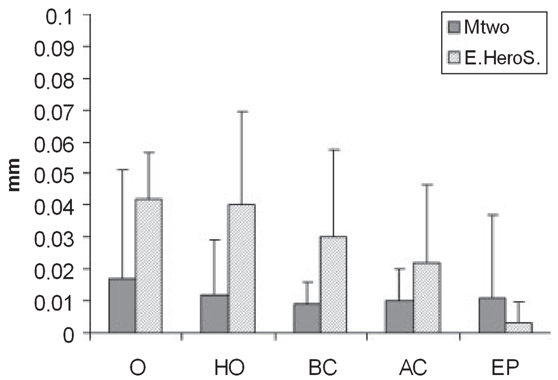

Figure 3 Canal symmetry at the five measurement points. The symmetry of preparation (an absolute value) was assessed by subtracting the amount of the removed inner dentin from that of the outer removed dentin. Lower values correspond to better centring. No significant differences were seen ($P > 0.05$).

Working safety

No canal aberrations, instrument blockages and fractures occurred. A mean loss of working length of 0.55 mm for Mtwo and 0.58 mm for Endoflare–Hero Shaper was measured although the difference was not significant.

Discussion

In both sequences, instrumentation time did not result in any statistically significant difference. Although the Mtwo sequence has fewer instruments than Hero Shaper, a brushing action had to be used before further advancing the instruments. Furthermore not all the instruments of the Hero Shaper sequence are required to fulfil the goal of shaping the root canal. These factors are likely to explain the lack of a difference between the systems.

The analysis of removed dentine showed that both the instruments cut uniformly at all the reference points with no significant differences between them. The instrumentation symmetry indicated that both systems maintained the original curvature, especially at the apical level, where, as shown in Fig. 3, low values indicated that the preparation was centred in the canal. More transportation was seen at the orifice (O) and the half-way orifice (HO) points, but this was probably because of the elimination of coronal and mid-root interferences.

Although there are no previous reports on either system, the Hero Shaper shares some features with Hero 642 and consequently a comparison is feasible. Conversely, given the new design of Mtwo, it is difficult to attempt any comparison. A good centring ability was reported when using Hero 642 in curved canals to a size 45, .02 taper, while more straightening resulted if limiting the preparation to size 35, .02 taper (Hülsmann *et al.* 2003). The present data seem to indicate that, by using a crown-down technique together with the Endoflare when beginning the shaping procedure, more dentine was removed from the coronal and the mid-root portions. Conversely, a centred preparation was achieved apically.

No aberration resulted, confirming the ability of NiTi instruments to respect canal anatomy (Glosson *et al.* 1995, Gambill *et al.* 1996, Bertrand *et al.* 2001, Schäfer 2001). The Hero Shaper, by having increased the helical pitch, seemed to have reduced the threading tendency reported for the Hero 642 on simulated canals (Thompson & Dummer 2000). The progression of the Mtwo instruments was easy to control. Working length showed minimal loss in both groups. Similar decreases also resulted previously for Hero 642 and Flexmaster (Thompson & Dummer 2000, Schäfer & Lohmann 2002), although the clinical relevance of these findings was not clear, due to mid-root straightening or imprecise length determination. González-Rodríguez & Ferrer-Luque (2004) and Schäfer (2001) reported fractures of Hero 642 .04 taper in curved canals and advised the use of instruments with greater diameters at the beginning of curved root shaping. Under the conditions of this study, where the Hero Shaper working sequence was adapted accordingly, no fractures resulted. However, warnings about separation from studies on other NiTi systems (Thompson & Dummer 2000, Schäfer 2001, Schäfer & Lohmann 2002, Yun & Kim 2003, Veltri *et al.* 2004), and the danger of separation without visible deformation suggests that the safest behaviour is still to use the instruments only once in canals exhibiting large, abrupt curvatures (Pruett *et al.* 1997).

To use the larger and stiffer instruments initially, as stated by Leeb (1983), can lead to an unobstructed apical access for the smaller files. For this reason, it seems convenient to use coronal flaring, and to possibly use a small file to maintain the patency of the root canal. Bryant *et al.* (1999) showed enhanced shapes, no aberrations and good working length control in simulated curved canals, when starting the sequence with Profile .06 followed by .04 instruments. Unlike the Hero Shaper, the Mtwo system was used according to the sequence suggested because each of these instruments is claimed to be able to enlarge the whole canal. As a result, a funnelled preparation is created since the use of the first instrument size 10, .04 taper. In addition, the final canal taper was different between the groups because the Hero Shaper sequence lacks a size 35. It was decided to use a size 35 Hero 642, .02 taper at this stage. However, despite the variation of the technique, no differences resulted.

Both sequences tested in this study respected canal anatomy and there were no instrument fractures. The Mtwo instruments cut dentine with their entire length and could advance all the way to the apex from the beginning of the sequence, consequently they are likely to be stressed more than the instruments used in a crown-down progression. However, in case of difficult progression, the selective enlargement of the most restrictive areas is advisable before continuing to advance the instruments. Obviously, the radiographic method used in the present study could not detect dentine removal as precisely as tomographic (Gambill *et al.* 1996) or cross-sectioning analysis (Bramante *et al.* 1987), consequently small differences between the two groups could be undetected. The other limitation is due to the possibility that small differences between the systems were not apparent due to the small sample size. Furthermore, considering the lack of studies on either system, prudence has to be used in extrapolating the results of these new instruments to clinical practice.

Conclusion

Under the conditions of this study, Endoflare–Hero Shaper and Mtwo were effective in shaping curved canals. Both respected the original canal anatomy, with no aberrations or failures resulting. Working time was similar in both groups.

Further studies are needed to evaluate the behaviour of the two systems and to investigate their cleaning ability three-dimensionally.

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