# Micro–computed Tomography Shaping Ability Assessment of the New Blue Thermal Treated Reciproc Instrument

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## Abstract

**Introduction:** The present study aimed to assess canal preparation outcomes achieved by the new Reciproc Blue instrument using micro–computed tomography technology. M-Wire Reciproc was used as a reference instrument for comparison. **Methods:** Seven pair-matched mesial roots of mandibular molars presenting similar anatomic features of the canal (length, volume, surface area, and configuration) were selected after scanning procedures and assigned to 1 of the 2 groups according to the instrument used, M-Wire Reciproc and Reciproc Blue. After canal instrumentation, the specimens were rescanned, and the registered preoperative and postoperative datasets were examined to evaluate the percentages of removed dentin, untouched canal walls, and degree of canal transportation. Comparisons regarding the above outcomes between the 2 groups were done by using paired *t* test with the alpha-type set at 5%. **Results:** Root canals prepared with conventional M-Wire Reciproc or Reciproc Blue were found to present similar shaping properties with no significant differences in the tested parameters. **Conclusions:** M-Wire Reciproc and Blue Reciproc presented similar shaping outcomes. *(J Endod 2018;■:1–5)*

## Key Words

Blue, micro-CT, Reciproc, reciprocating, shaping ability, thermal treated

**Significance**

This study highlighted that the new Reciproc Blue instrument presented similar shaping performance compared with the M-Wire Reciproc instrument.

The rise of the asymmetric reciprocating movement made possible the use of a single nickel-titanium (NiTi) instrument to safely enlarge the root canal into a minimum acceptable taper size (1). This approach is appealing because of the simplification of the technical procedure but also from a cost-effective perspective. Nowadays, there is a well-built background showing the benefits of the reciprocating movement (2–6). The first reciprocating systems were made in M-Wire alloy, which was a welcome innovation in 2010 because fracture associated to cyclic fatigue used to be the primary concern for rotary instruments made of regular NiTi alloys, especially in severely curved canals (7, 8). M-Wire alloy is processed by a proprietary thermomechanical procedure that yields markedly improved mechanical properties of the instrument such as longer cyclic fatigue resistance and increased flexibility when compared with conventional superelastic NiTi wire, because its heat treatment optimizes the microstructure of NiTi wire (9, 10).

From then on, metallurgical heat treatment of NiTi alloys has been effectively used to improve the mechanical properties of instruments, which include fatigue resistance, flexibility, cutting efficiency, and canal centering ability (9–12). Recently, Reciproc Blue system (VDW, Munich, Germany) was introduced. This instrument is made of a wire created by an innovative thermal treatment, which comprises a complex heating-cooling proprietary treatment that results in a visible titanium oxide layer in the surface of the instrument (12). This thermal treatment regulates the phase transition temperatures, rendering part of the crystallographic structure of the alloy and thus providing the instrument with a blue color and, at the same time, creating a predetermined shape memory.

The shaping ability of the M-Wire Reciproc instrument (VDW) was already tested through micro–computed tomography (micro-CT) imaging, and the results showed that this single-file approach was able to mechanically prepare the root canals at the same standard as conventional multi-file rotary systems (13–16). The percentage of non-instrumented canal areas after the use of M-Wire Reciproc instrument is in the range of 18.95%–44.4% (13, 14, 16); however, this outcome is still unknown with the new Reciproc Blue instrument. The blue heat treatment is related to increased

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flexibility and cyclic fatigue resistance (12, 17). Moreover, because of this heat treatment, Reciproc Blue is softer than its predecessor. From a clinical perspective, this feature may have some impact on its shaping ability.

Within this background, the present study was designed to quantitatively assess root canal preparation outcomes achieved by the new Reciproc Blue instrument. M-Wire Reciproc instrument was used as a reference for comparison. High-definition micro-CT technology was used as an analytical tool to compare the following parameters in matched pairs of extracted human mandibular molars: removed dentin, non-instrumented canal area, and canal transportation. The null hypothesis tested was that there would be no differences between the instruments regarding any of the investigated parameters.

## Materials and Methods

### Sample Size Calculation

An *a priori* independent samples test was selected from the *t* tests family (G*Power 3.1 for Macintosh; Heinrich Heine, Universitat Dusseldorf, Dusseldorf, Germany). The effect size (0.91) was determined by using data from De-Deus et al (14), in which the shaping ability was assessed. Other parameters were used as follows: $\alpha$ error = 0.05 and power $\beta$ = 0.80. Ten specimens (5 anatomically pair-matched teeth) were indicated as the sample size needed to observe significant differences between the groups.

### Sample Selection

After approval of the local Ethics Committee, 105 human mandibular first and second molars with moderately curved mesial roots (10°–20°) were selected from a pool of teeth and stored in 0.1% thymol solution at 5°C. Digital radiographs taken in buccolingual direction were used to calculate the angle of curvature by using AxioVision 4.5 software (Carl Zeiss Vision GmbH, Hallbergmoos, Germany) according to the method of Schneider (18).

The specimens were scanned in a micro-CT device (SkyScan 1173; Bruker micro-CT, Kontich, Belgium) operated at 70 kV and 114 mA by using an isotropic pixel size of 14.25 $\mu$m, 180° rotation around the vertical axis, rotation step of 0.7°, and frame averaging of 3, with a 1.0-mm-thick aluminum filter to obtain an outline of the root canals. The acquired projection images were reconstructed with NRecon v.1.6.10 software (Bruker micro-CT), providing axial cross sections of their inner structure by using standardized parameters for beam hardening (30%), ring artifact correction of 5, and similar contrast limits. The volume of interest extended from the cementoenamel junction to the apex of the root, resulting in the acquisition of 700–800 transverse cross sections per tooth. According to Fan et al (19), only teeth presenting mesial roots with isthmi type I (narrow sheet and complete connection existing between 2 canals) or III (incomplete isthmus existing above or below a complete isthmus) were included. In addition, to create homogeneity between the groups and ensure some margin of confidence, 7 anatomically pair-matched teeth were selected on the basis of similar morphologic features of the canal such as length, volume, surface area, and configuration to compose the experimental groups. Figure 1 shows the anatomically pair-matched samples.

### Root Canal Preparation

After access cavity preparation, the working length (WL) was determined by passing a #10 K-file (Dentsply Sirona Endodontics, Ballaigues, Switzerland) through the major foramen and withdrawing it 1.0 mm. Next, the apical foramen of each mesial root was sealed with

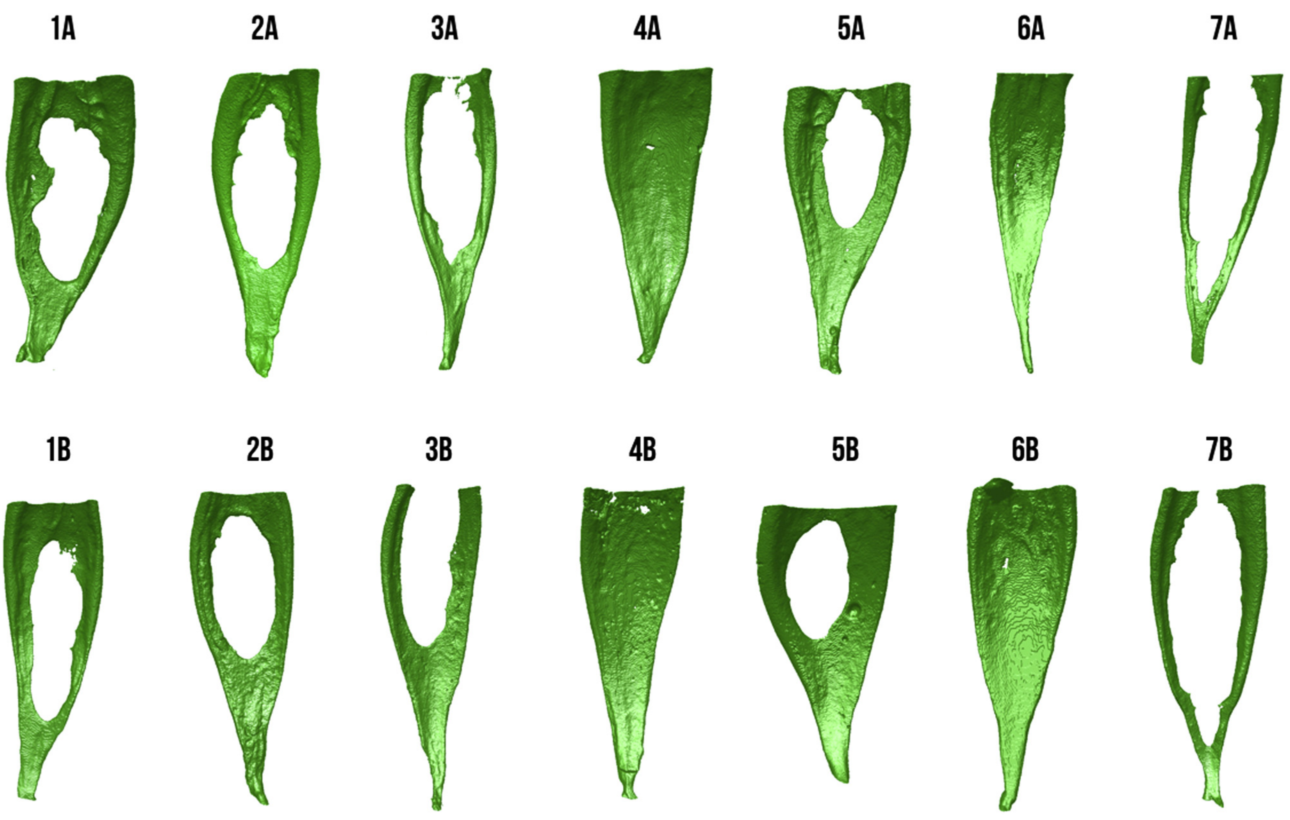


**Figure 1.** Representative three-dimensional models of the mesial canals of the 7 anatomically pair-matched teeth.