ORIGINAL RESEARCH

A Comparison of Mtwo and RaCe Rotary Instruments in the Preparation of Curved Canals

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Abstract

Aim: The aim of this study was to compare the effectiveness of Mtwo and RaCe rotary instruments in cleaning and shaping root canals curvature.

Materials and methods: The present study was conducted on 160 simulated canals in resin blocks with an angle curvature of 15°–30°. These 160 simulated canals were divided into two groups, where each group consisted of 80 blocks. In the first group, the canals were prepared using Mtwo rotary system (VDW, Munich, Germany). In the second group, the canals were prepared using RaCe instruments (La Chaux-De-Fonds, Switzerland). The data were recorded using SPSS version 23 software (Microsoft, IL, USA).

Results: The results obtained by using the Mtwo rotary instruments showed that these instruments were able to clean and shape in the right-to-left motion curved canals, at different levels, without any deviation and in perfect symmetry, with a p value = 0.000. The data showed that greater the depth of the root canal, greater the deviations of the RaCe rotary instruments. These deviations occurred in three levels, which are the following: S2 ($p = 0.004$), S3 ($p = 0.007$), and S4 ($p = 0.009$). The Mtwo files can go deeper and create a greater angle in S4 level (21°–28°) compared to RaCe instruments with an angle equal to 19°–24°.

Conclusion: The present study noted a clinical significant difference between Mtwo rotary instruments and RaCe rotary files used for the canal preparation and indicated that Mtwo instruments are a better choice for the curved canals.

Clinical significance: There are a large number of procedures and instruments used in the preparation of the root canal. Mtwo and RaCe rotary files were the instruments taken under comparison, in order to determine which of them would perform better.

Keywords: Canal curvature, Canal preparation, Mtwo, RaCe, Resin blocks.

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Introduction

Root canal preparation using nickel–titanium (NiTi) rotary systems is a great achievement in dentistry, while root canal cleaning is an important step in endodontic therapy.[1,2] In order to improve the techniques of canal preparation, new endodontic instruments have been created.[3,4] One of the most successful NiTi rotary systems is Mtwo. It has a cross-section shape in the form of an "italic S" with two cutting blades. The rake angle of Mtwo enhances the cutting efficiency of this instrument. Mtwo tip is noncutting, that is why the variable helical angle reduces the tendency of the instrument to get stucked into the canal.[5]

The basic set of Mtwo rotary files includes four instruments with variable tip sizes ranging from no. 10 to no. 25, tapers ranging from 0.04 to 0.06–0.07, and two lengths: 21 and 25 mm. Also file tips range in size from 30, 35, and 40 and tapers of 0.5, 0.4, and 0.7 are available.[6]

Mtwo instruments preserve the original structure of the teeth without doing an early coronal enlargement. Each instrument is used up to the working length without apical pressure. In the moment when a tight contact is sensed by a clinician, the instrument is withdrawn 1–2 mm so that it can be used as a brushing action that will selectively remove the interferences and go toward the apex.[7]

In order to obtain a circumferential cut, the Mtwo instruments are used with a lateral pressing movement.[8]

Plotino et al.[9] showed that the fatigue of Mtwo instrument was reduced using a lateral brushing. Mtwo instruments have lower risk of instrument fracture and have the ability to clean and shape symmetrically the root canal curvatures, and also due to their S-shaped cross-section, it can perform effectively lateral cutting.

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Several studies proved that all Mtwo files should be used for the full length of the root canal.[10] The specific design and the flexibility of Mtwo instruments make these files effective and safe, so cleaning can be completed in less time.[11–13]

Recently, a new Mtwo instrument design has been introduced (VDW, Munich, Germany). This type of instruments has the same S-shaped cross-sectional design with a noncutting tip. This design is claimed to eliminate threading and binding in continuous rotation and to reduce transportation of debris toward the apex.[14]

The basic series of Mtwo instruments includes eight instruments, with tapers ranging between 0.04 and 0.07 and sizes from ISO 10–40. The manufacturers claim that a crown-down instrumentation sequence is no longer required, since the Mtwo files can be used to the full working length of the root canal as well as to shape the entire length of it, whereas RaCe instruments

have a triangular alternating cross-sectional cutting, which reduces intraoperative torque values.[15]

The RaCe instruments create dentinal defects that may be related to the cross-sectional design of the files, also with the fact that RaCe instruments have extremely sharp cut ends. According to the manufacturer, the design of the RaCe instruments reduces the speed and the screw-in effect within the root canal.[16]

The main objective of RaCe instruments is to create larger apical diameters that will help the chemical irritant penetrate better; in this way, the clinician will obtain a greater microbial reduction.[17,18] Other studies claimed that RaCe system leaves small areas of untouched dentin walls in the middle and cervical thirds.[19]

This purpose of this study was to compare the effectiveness of Mtwo and RaCe rotary instruments in cleaning and shaping root canals curvature, while the objective was to achieve a more biological canal preparation and preserve the anatomic structure of the teeth.

Materials and Methods

The present study was conducted on 160 simulated canals in resin blocks with an angle curvature of 15°–30°. These 160 simulated canals were divided into two groups, where each group consisted of 80 blocks. Each group was divided into two subgroups ($n = 40$ canals each). The remained 80 blocks served as the control group. During the preparation, the blocks were fixed using a container.

The simulated canal subgroups were prepared with Mtwo and RaCe rotary nickel–titanium instruments. All the resin specimens were photographed, before and after instrumentation. The root canals were measured at four different points of reference, starting at 13 mm from the orifice.

Simulated Canals

All instruments were used to shape and clean only four simulated canals, using the crown-down technique. Each instrument, before using it was coated into glycerine, which served as a lubricant. Also after the use of each instrument, a copious irrigation with water was done.

Three clinicians conducted the measurements of the canals. After the preparation of the access cavity, the apical patency of the canals was examined using #10 and #15 K-files (Mani Co., Tokyo, Japan).

As already mentioned, the sample was divided into two subgroups ($n = 40$). In the first group, the canals were prepared using Mtwo rotary system (VDW, Munich, Germany). The Mtwo files used were as follows: 10/0.04, 15/0.05, 20/0.06, and 25/0.06. These instruments entered in the full length of the canal. Each file was rotated in the canal until it reached the apical point.

In the second group, the canals were prepared using RaCe instruments (La Chaux-De-Fonds, Switzerland), performing the crown-down technique, using the torque electric control motor (VDWCO, Munich, Germany), with 600 rpm and 2 N/cm as follows: ≠40/0.10, ≠35/0.08, ≠30/0.06, ≠25/0.04, and ≠25/0.02.

According to the instructions of the manufacturer, the RaCe rotary files used were as follows: 40/0.10 at 5 mm, 35/0.08 at 7 mm, 30/0.06 at 9 mm, and 25/0.04 at 11 mm, and the instrument 25/0.02 was utilized at 13 mm, which is the full length of the canal.

The examiners took images of the instrumented sample using the optical microscope at a magnification power of 50×, with the help of a Mitutoyo Profile Projector. After that, these images were compared using the autocad program, in order to evaluate the differences before and after the instrumentation, at the four different lengths of the canals.

Based on the results, this study evaluates the shaping ability of these two rotary systems, in relation to specific lengths of the root canals. The results were analyzed using analysis of variance (ANOVA)-test.

The following parameters were taken in consideration observing the four different lengths of the canal.

Ai is the angle of the canal axis, and it was calculated based on the angle formed with the vertical, which passes in the equidistant points of the canal axis, before the preparation.

RMXi is the distance of the right margin of the canal, from the right side of the resin block.

LMXi is the distance of the left margin of the canal, from the left side of the resin block.

RMXi–LMXi are the distances of the right and the left margins of the canal, evaluated in relation to the right and the left sides of the resin block. This alteration of canal morphology allows us to evaluate the cutting capacity of the instruments.

ai is the angle between the tangent and the canal axis.

After the instrumentation were evaluated the following characteristics:

- Lateral cutting capacity
- Respecting the anatomy of the root canal

Not prepared canals—control group

To standardize the samples, this study took into consideration simulated canal blocks, which were not instrumented ($n = 80$). These blocks were divided into two groups that served as control groups, in order to evaluate the differences between Mtwo and RaCe rotary systems.

The root canal was divided into four heights: S1 = 13 mm, S2 = 10 mm, S3 = 4 mm, and S4 = 3 mm and the canal curvature was evaluated at these four heights in order to determine the greatest change. The data were recorded using SPSS version 23 software (Microsoft, IL, USA). Data analysis was done using ANOVA test.

Results

Mtwo instruments can facilitate canal preparation. The results obtained by using the Mtwo rotary instruments showed that these instruments were able to clean and shape in the right-to-left motion, at different levels, without any deviation and in perfect symmetry, curved canals, with a p value = 0.000. Again, based on the results of the present study, Mtwo instruments did not change the original canal curvature and showed good shaping ability in these curved canals. Statistical analysis revealed that Mtwo instruments had the capacity of lateral cutting (Table 1).

The results obtained by using the RaCe rotary instruments showed that these instruments worked asymmetrically from the right to the left motion. The data showed that greater the depth of the root canal, greater the deviations of the RaCe rotary instruments. These deviations occurred in three levels, which are the following: S2 ($p = 0.004$), S3 ($p = 0.007$), and S4 ($p = 0.009$) (Table 2).

Statistical analysis showed that Mtwo instrument achieved the highest accuracy in S1 level, because the deviations were equal to zero. While in the other levels: S2, S3, and S4, the deviations were equal to 0.03, 0.31, and 0.43, respectively. The results of the present study claimed that the Mtwo instruments preserved the original shape of curved canals during preparation (Table 3).

Table 1: *p* value of different canal lengths (S1–S4) using Mtwo instruments

Four different lengths of the canal treated with Mtwo	*p value*
S1-Mtwo-LMXi	0.000
S1-Mtwo-RMXi	
S2-Mtwo-LMXi	0.000
S2-Mtwo-RMXi	
S3-Mtwo-LMXi	0.000
S3-Mtwo-RMXi	
S4-Mtwo-LMXi	0.000
S4-Mtwo-RMXi	

Table 2: *p* value of different canal lengths (S1–S4) using RaCe instruments

Four different lengths of the canal treated with RaCe	*p value*
S1-RaCe-LMXi	0.000
S1-RaCe-RMXi	
S2-RaCe-LMXi	0.004
S2-RaCe-RMXi	
S3-RaCe-LMXi	0.007
S3-RaCe-RMXi	
S4-RaCe-LMXi	0.009
S4-RaCe-RMXi	

Table 3: Mean and the standard deviation of canals treated with Mtwo instruments

Canals treated with Mtwo instruments	*Mean*	*Standard deviation*
S1-Mtwo-LMXi	0.61	0.01
S2-Mtwo-LMXi	0.50	0.01
S3-Mtwo-LMXi	0.70	0.01
S4-Mtwo-LMXi	1.08	0.02
S1-Mtwo-RMXi	0.61	0.01
S2-Mtwo-RMXi	0.53	0.02
S3-Mtwo-RMXi	1.01	0.01
S4-Mtwo-RMXi	1.51	0.02
S1-Mtwo-Ai	0.02	0.01
S2-Mtwo-Ai	0.08	0.004
S3-Mtwo-Ai	0.67	0.007
S4-Mtwo-Ai	1.25	0.01
S1-Mtwo-ai	0.00	0.00
S2-Mtwo-ai	2.00	0.00
S3-Mtwo-ai	21.00	0.00
S4-Mtwo-ai	28.00	0.00

In the root canal treated with RaCe instruments, the deviations of the S1 level were equal to 0.09 and in S2 level, the deviations were 0.04, similarly to the deviations of Mtwo instruments (0.03), while in S3 and S4, the deviations of the RaCe instruments were 0.33 and 0.72 (Table 4).

Table 4: Mean and the standard deviation of canals treated with RaCe instruments

Canals treated with RaCe instruments	*Mean*	*Standard deviation*
S1-RaCe-LMXi	0.76	0.02
S2-RaCe-LMXi	0.66	0.02
S3-RaCe-LMXi	0.78	0.03
S4-RaCe-LMXi	0.95	0.05
S1-RaCe-RMXi	0.67	0.02
S2-RaCe-RMXi	0.70	0.04
S3-RaCe-RMXi	1.11	0.02
S4-RaCe-RMXi	1.67	0.05
S1-RaCe-Ai	0.10	0.01
S2-RaCe-Ai	0.10	0.01
S3-RaCe-Ai	0.72	0.01
S4-RaCe-Ai	1.29	0.01
S1-RaCe-ai	0.00	0.00
S2-RaCe-ai	2.00	0.00
S3-RaCe-ai	19.00	0.00
S4-RaCe-ai	24.00	0.00

Discussion

The present study compared the abilities of Mtwo and RaCe rotary instruments in the preparation of curved canals. The process was conducted in laboratory conditions, using simulated resin blocks.

Several studies pointed out that the main objective of endodontic is to shape the root canal without any deviation from the original position of the canal.[20,21]

The present research, found out that the Mtwo rotary files used, had the same length and its advantages were the following: the Mtwo files respected the canal anatomy, causing no change to the working length, similar results were obtained by Santoro et al.[22] Mtwo instruments have a S-shaped cross-sectional design, which reduces the extrusion of debris beyond the apex and has a positive rake angle that can effectively cut the dentin.[23]

This study noticed that Mtwo instruments can equally remove the inner and the outer walls of the canals, thus creates a more anatomic form of the canal. According to the results of this study, the form of the Mtwo instrument pulls the instrument down, whereas the operator should only rotate it. Mtwo instruments work at a rotational speed of 300 rpm. Based on the present study observations and analysis, Professor Malagnino noticed that if the speed rotations increase, the instrument will get fractured and the endodontic procedure will fail. The clinicians can enter the canal faster using Mtwo instruments of lower conicity 10/04. Also this research proved that while raising the instrument conicity, the root canals will be cleaned laterally. Mtwo instruments create a conical shape in the apical point, starting from the first millimeter. Based on our findings, Mtwo instruments are able to clean all the diameters and the working length of the canals. Simulated root canals have different angles at different heights and the present study proved that Mtwo instruments respected the axis of canal at each height, from S1 to S4. Mtwo files flexibility helped these instruments follow the angles better.

In order to determine the capacity of Mtwo instruments, this study measured the distance of the right and left margins of the canals.

Veltri et al.[24] found out that apex anatomy was respected using Mtwo instruments in the apical region. These data were similar to our findings.

In this study, no Mtwo instrument was reported fractured. This finding is in accordance with other studies conducted by Schäfer,

Vlassis[16] and Veltri et al.[24] The results showed that Mtwo instruments caused a greater widening of the root canals. In the S1 level, with a depth of 13 mm in the root canal, the angle deviation for the Mtwo instruments was 0°, while at S2 level with a depth of 10 mm, the angle deviation was 2°. In the S3 level, Mtwo creates an angle equal to 21°, but these instruments can go deeper and create a greater angle in S4 level (21°–28°).

The results showed that RaCe instruments, in the S1 level, with a depth of 13 mm in the root canal, the angle deviation was 0°, while in the S2 level, with a depth of 10 mm, the angle deviation was 2°. In the S3 level, RaCe creates an angle equal to 19°, but these instruments can create a greater angle in the S4 level (19°–24°).

The results of this study showed that Mtwo files work with larger angles than RaCe instruments, that is why Mtwo instruments should be taken more in consideration.

NiTi instrument characteristics, such as elasticity and shape memory, allow Mtwo and RaCe files to preserve the original anatomy of curved canals.[25,26]

Several studies compared the effectiveness of rotary NiTi files and manual instruments in cleaning root canals and they came at the conclusion that NiTi rotary systems are faster than manual files, reduce errors during the preparation of the root canals, and preserve the shape of the root canals.[27–29]

This study proved that Mtwo instruments were highly effective in cleaning and shaping curved canals, and similar results were obtained by, Gu et al.,[30] in their study.

Based on the deviations occurred in the three levels measured, which were S2 ($p = 0.004$), S3 ($p = 0.007$), and S4 ($p = 0.009$), this study can claim that RaCe files were less effective than Mtwo files. Again based on the results, the present study can prove that Mtwo instruments had no deviations at different levels of the canals, and the lateral sides of these canals were in perfect symmetry, with (p value = 0.000).

These results reflect that Mtwo rotary files had a better cutting ability, had fewer preparation errors, and had higher flexibility, in comparison to RaCe rotary files.

According to Andrade-Junior et al.,[31] RaCe instruments revealed some canal deviations at all levels, and their findings are similar to the findings of this study.

The RaCe files have a sharp cutting edge with convex triangular cross-section with an asymmetrical longitudinal design. The study observed that RaCe files had different cutting edges on the same file, and this could create stress concentration at specific points which can cause cracks in the instruments.[32]

Garg et al.,[33] in their study conducted on 150 extracted mandibular premolars, showed that cracks were found in 10% and 16.7% of the canals prepared with K3 and RaCe files, respectively.

Merrett et al.[34] reported fractures of the RaCe files. The present study also reported that four RaCe files were broken, while none of the Mtwo instruments used was fractured.

There are evidences, which prove that NiTi files although have the capacity to preserve the original shape of the canal, they can cause straightening of it if the instrument is left too long within the canal.[35]

Another study conducted by Bürklein et al.[36] found out that Mtwo instruments maintained the original curvature of the natural teeth, without any deviations.

The present study was done on simulated root canals in resin blocks, and using these simulated canals is an effective method for comparing different root canal instruments.[37,38]

The advantages of using resin blocks include the standardization of the canals' shape and anatomy, the elimination of tooth-related factor, and these resin blocks facilitate the clinicians' work.[39]

Based on the results of this study, Mtwo files performed significantly better in cleaning and shaping the whole canal length.

The process of preparing the root canal curvature becomes more difficult if you get deeper into the root canal. However, this study proved that Mtwo instruments bends better than RaCe instruments and cleans the canal length better.

This study showed that Mtwo instruments prepared curved canals in a uniform and synchronized way, as it cleans from the left to the right.

Conclusion

The present study noted a clinical significant difference between Mtwo rotary instruments and RaCe rotary files used for the canal preparation and indicated that Mtwo instruments are a better choice for the curved canals.

Clinical Significance

There are a large number of procedures and instruments used in the preparation of the root canal. Mtwo and RaCe rotary files were the instruments taken under comparison, in order to determine which of them would perform better.

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