치의학박사학위논문

Shaping Ability of Reciproc Files and Mtwo System Used in Continuous and Reciprocating Motion : A Micro-computed Tomographic Study

미세 전산화 단층 촬영술을 이용한 Reciproc 파일과 일방 회전식 및 양방 회전식으로 사용한 Mtwo 파일의 근관 성형능 비교 연구

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- Abstract -

Shaping Ability of Reciproc Files and Mtwo System Used in Continuous and Reciprocating Motion : A Micro-computed Tomographic Study

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Objectives

This study compared the shaping ability of Mtwo (VDW, Munich, Germany), a conventional nickel-titanium file system with reciprocating motion, and Reciproc (VDW), a reciprocating file system morphologically similar to Mtwo using micro-computed tomography.

Materials and Methods

Root canal shaping was performed on the mesiobuccal or distobuccal canals of extracted human maxillary molars. In the RR group (n = 15), Reciproc file was used in a reciprocating motion (150° counterclockwise / 30° clockwise, 300 rpm); in the MR group, Mtwo file was used in a reciprocating motion (150°

clockwise/ 30° counterclockwise, 300 rpm); and in the MC group, Mtwo file was used in a continuous rotating motion (300 rpm). Micro-computed tomographic images taken before and after canal shaping were used to analyze canal volume change and the degree of transportation at the cervical, middle, and apical levels. The time required for canal shaping was recorded. Afterward, each file was observed using scanning electron microscopy(SEM) to detect file deformation. The preparation time, degree of transportation, and root canal volume change of the 3 groups were analyzed by one way analysis of variance. Post hoc analysis was performed by the Tukey post hoc test. The significance level was set at $p < .05$.

Results

No statistically significant differences were found among the 3 groups in the time for canal shaping or canal volume change ($p > .05$). Transportation values of the RR and MR groups were not significantly different at any level. However, the transportation value of the MC group was significantly higher than both the RR and MR groups at the cervical and apical levels ($p < .05$). In the SEM analysis, file deformation including unwinding and twisting of helical structure was observed for 1 file in group RR, 3 files in group MR, and 5 files in group MC.

Conclusions

Mtwo used in a reciprocating motion was comparable to the Reciproc system in terms of shaping ability and preparation time.

Key Word : Micro-computed Tomography, Reciprocating motion, Continuous rotating motion, Root canal transportation, Nickel-titanium file, Shaping ability

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I. Introduction

The goal of root canal instrumentation is to remove all the infected pulp tissue, bacteria, and their by-products and thus to make canal shape that is suitable for canal filling. It is considered that an effective cleaning and shaping procedure is essential for achieving this goal (1). Root canal shaping procedure is the utmost important step during endodontic treatment, and it eventually affects the following steps such as canal irrigation and canal obturation (2). However, it is very difficult to maintain the original shape of the root canal, and procedural errors such as ledge, zip, and transportation commonly occur because most canals are curved and instruments tend to straighten up in the canal. Complete removal of infected tissue or bacteria and so on is not easy because the procedural errors during canal shaping cause inappropriate dentin removal and straightening of curved canals. Also, transportation above a certain level hinders complete sealing during the canal filling process (3, 4).

An introduction of Nickel-titanium (NiTi) file system in the field of endondontics brought upon a revolutionary change in terms of quality enhancement of endondontic treatment (5, 6). They have many advantages over hand files that are made of stainless steel. NiTi files have excellent flexibility compared with stainless steel files (7). Since super-elasticity of NiTi files applies less amount of lateral force against canal walls, canal aberration of curved canal could be prevented and also, original canal shapes are more likely to be maintained (8, 9). Also, a higher cutting efficiency of NiTi files shortens operative time (10, 11). However, NiTi files are still at risk of fracture through flexural fatigue and torsional stresses (12).

A recently introduced canal shaping method using a reciprocating motion has been reported to significantly improve the cyclic fatigue life of the instrument compared with conventional continuous rotation (13-18). The use of new file systems designed for only reciprocating movements using a specific motor is on the rise. Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) are examples of such systems currently available on the market.

Reciproc is similar to Mtwo (VDW), which is a previously introduced NiTi file system made by the same manufacturer. Comparing the cross-sectional views of these 2 files, they form mirror images because of their identical symmetrical shapes but opposite helical directions (Fig. 1). The reciprocating motion, which is installed in the motor specific for Reciproc, comprises counterclockwise (cutting direction) and clockwise motions (release of the instrument). The instrument proceeds toward the apex because the counterclockwise rotation angle is larger than the clockwise angle. According to a previous study, counterclockwise and clockwise rotation angles were revealed by the manufacturer to be 150° and 30°, respectively (19).

Several studies have reported satisfactory results using ProTaper F2 (Dentsply Maillefer) in a reciprocating motion when cyclic fatigue resistance and shaping ability were measured (14, 19-22). Based on these results, it may be possible for canal shaping using a conventional rotary NiTi file system in a reciprocating motion to be applied clinically.

What is particularly interesting about ProTaper F2 is that, although it is not specifically designed for reciprocating motion, it could shape the canal to full length. ProTaper F2 cannot shape the canal to full length when it is used in a conventional continuous rotating motion. However, few studies have applied a reciprocating motion to conventional rotary NiTi files like ProTaper F2 (23, 24).

The aim of this study was to analyze and compare the root canal shaping ability of Reciproc, a reciprocating file system, and Mtwo, a conventional NiTi file system with reciprocating motion that is morphologically similar to Reciproc, using micro-computed tomographic (micro-CT) imaging. In addition, file deformation after canal shaping was examined by scanning electron microscopy.

II. Materials and Methods

Tooth Selection

Procedures for this study were approved by the Seoul National University Dental Hospital Institutional Review Board (CRI13009). Mesiobuccal and distobuccal canals of extracted maxillary molars with complete apices were selected for this study. Intact teeth without dental caries or fractures were collected and stored in 0.1% thymol solution. The teeth used in this study were extracted because of reasons irrelevant to this investigation such as periodontal disease. Soft tissue was removed using periodontal curettes. After the teeth were cleaned, radiographs were taken. Canal curvatures were measured according to the Schneider method (25), and teeth belonging to the 20°–45° range were included in the experiment. Using #4 round and Endo Z burs (Dentsply Maillefer), access openings were created and straight-line access was achieved for each tooth. The working length was determined by inserting a #08 K-file (Dentsply Maillefer) until its tip could be seen through the apical foramen, after which 1 mm was deducted. The glide path was formed using #15 K-files.

Canal Preparation

The mesiobuccal and distobuccal canals of the selected maxillary molars were randomly divided into 3 groups of 15 canals each (RR group: Reciproc used in a reciprocating motion, MR group: Mtwo used in a reciprocating motion, and MC group: Mtwo used in a continuous motion). In the RR group, Reciproc R25 was used. And, in the MR and MC group, Mtwo 25.07 which has the most similar taper was used since R25 has 08 taper at apical end 3mm. The cross sectional diameters and tapers of the instruments from manufacturer are described in table 1. The curvature, volume, and surface area of the canals in each group were measured to evaluate differences between the 3 groups.

RR Group (n = 15)

Using Reciproc, R25, canal shaping was performed with a reciprocating motion at 300 rpm to the working length. The rotation angle was set at 150° counterclockwise and 30° clockwise.

MR Group (n = 15)

Using an Mtwo #25.07 file, canal shaping was performed with a reciprocating motion in a 150° clockwise and 30° counterclockwise direction at 300 rpm to the working length.

MC Group (n = 15)

Using an Mtwo #25.07 file, canal shaping was performed with a 2.0 Ncm continuous rotating motion at 300 rpm to the working length.

For each canal, only 1 new instrument was used, and transformation or defect of the instrument was checked beforehand using surgical microscope (Carl Zeiss surgical GmbH; Carl Zeiss, Oberkochen, Germany). Canal shaping was performed using an electric motor (I-Endo dual; Acteon, Merignac, France) by 1 experienced clinician. The instrument was used in slow in-and-out pecking motions, and the amplitude of the in-and-out movements was set to be lower than 3 mm. After each pecking motion, debris was removed from the flute, and canal irrigation was performed using 1ml of 5.25% sodium hypochlorite with 30-G side-vented irrigating tip. All canal shaping was performed using RC-Prep (Premier Dental Product, Norristown, PA, USA) as a lubricating agent. Pecking motion done after the instrument reached up to working length was limited to 3 and less times. Final irrigation was performed using 3ml of 5.25% sodium hypochlorite. The procedure time for each shaping was recorded. Only the time required for canal shaping using an instrument was included, and the times for cleaning the canal, and removing debris from the instrument were excluded.

Micro-CT Analysis

Teeth were fixed using customized jigs to prevent a change in location, and micro-CT images were obtained before and after canal shaping. The micro-CT system (Skyscan 1172; Skyscan b.v.b.a., Aartselaar, Belgium) was used at settings of 100 kV, 100 Ma, and 16 μm with isotropic resolution. Slices were 1000x1000 pixels with a pixel size of 16 μm.

Measurement of the Root Canal Volume

Using CTAn v 1.12 (Bruker micro-CT, Kontich, Belgium), an image analysis software package for micro-CT imaging, the canal volume from the canal orifice to the apical foramen was measured before and after canal shaping, and the change in volume was obtained.

Measurement of Root Canal Transportation

The entire canal from the apical foramen to the canal orifice was divided into coronal, middle, and apical thirds. Cross-sectional images at the middle point of each third were used to assess the degree of transportation according to the following equation suggested by Gambill et al (7): Transportation value = (X1-X2)-(Y1-Y2), where X1 is the shortest distance from the outside of the curved root to the periphery of the uninstrumented canal, Y1 is the shortest distance from the inside of the curved root to the periphery of the uninstrumented canal, X2 is the shortest distance from the outside of the curved root to the periphery of the instrumented canal, and Y2 is the shortest distance from the inside of the curved root to the periphery of the instrumented canal. A value of 0 from this equation indicates that no canal transportation occurred. A positive value indicates that transportation occurred outwardly from the canal, and a negative value indicates that transportation occurred inwardly. The measuring spot and method of transportation value are depicted respectively in figures 2 and 3.

Scanning Electron Microscopic Analysis

The surfaces of each file were observed to detect file deformation under a scanning electron microscope (Hitachi S-4700, Tokyo, Japan) at 30x and 300x as received and after canal shaping.

Statistical Analysis

Before canal shaping, one-way analysis of variance was performed to compare root canal curvature, root canal volume, and root canal surface area between the 3 groups. After canal shaping, the preparation time, degree of transportation, and root canal volume change of the 3 groups were analyzed by one-way analysis of variance. Post hoc analysis was performed by the Tukey post hoc test. The significance level was set at $p < .05$.

III. Results

Information on baseline characteristics before canal shaping of the canals which belong to each groups are shown in table 2. The mean canal curvature of each groups were 25.40±1.49° in

RR group, 24.67±1.58° in MR group, and 23.07±1.08° in MC group. There were no significant differences between the 3 groups in root canal curvature, root canal volume, and root canal surface area before root canal instrumentation.

The time consumed in canal shaping of each group was RR group: 80.67±0.88s, MR group: 71.47±4.07s, and MC group: 74.20±4.30s. And no difference existed between groups (Table 3). Canal volume before and after canal shaping is shown in table 4, and the canal volume changes were RR group: 0.79±0.14 mm^3, MR group: 1.37±0.18mm^3, and MC group: 1.13±0.17mm^3. And there was no statistical difference between groups (Table 4).

Pre- and post-operative cross sectional micro CT images of each group are depicted in figure 4. The transportation values measured at the cervical, middle, and apical levels are listed in Table 5 and 6. Table 5 stands for each measurement value in all the canals belonging to each group, and table 6 stands for the mean value and statistical difference. It was found, judging from the result that transportation values were all negative at coronal third and middle third level in all three groups, that transportation occurred on the inside of the canal curvature. Also, transportation values at apical thirds were positive in all three groups. This result indicates that transportation occurred on the outside of the curvature.

Transportation values measured in cervical level were RR group: -0.11±0.08mm, MR group: -0.07±0.06mm and MC group: -0.35±0.05mm. And transportation values measured in apical level were RR group: 0.07±0.03mm, MR group: 0.02±0.03mm, and MC group: 0.20±0.04mm. The RR and MR groups exhibited no significant difference in transportation at any of the 3 levels. However, the MC group was significantly different from the RR and MR groups at the cervical and apical levels ($p < .05$).

File fracture during canal preparation was not observed in any of the 3 groups. However, scanning electron microscopy revealed file deformation, including unwinding and twisting of the helical structure in 1 file in the RR group (1/15), 3 files in the MR group (3/15), and 5 files in the MC group (5/15) (Fig. 5).

IV. Discussion

This study compared shaping ability of Reciproc, a reciprocating NiTi file system, and Mtwo, a conventional rotary NiTi file system. Reciproc consists of what was called M-wire, a special heat-treated NiTi alloy, and R25 was selected from among 3 different sizes (R25, R40, and R50). The 3-mm tip portion of R25 was a 08 taper, and for Mtwo a 07 taper was used so that the experimental conditions could be similar. Because Reciproc functions in both counterclockwise (cutting direction) and clockwise (release of the instrument) directions and the helical direction of the Mtwo is the opposite of Reciproc, each angle was oppositely applied.

The results of this study showed no significant difference between groups in root canal volume change after canal shaping. This is probably because the groups were structured so that there was no difference in root canal volume between the groups before canal shaping. The instrument volume of Reciproc R25 and Mtwo 25.07 is similar.

The lengths of working parts of Reciproc R25 and Mtwo 25.07 were 16mm, and the cross section diameters of the instruments are described in table 1. The reason why post-operative canal volume change of RR group was less than those of MR group or MC group, although statistically not significant, is thought to be because R25 has a type of a structure that its taper steeply decreases towards the coronal part.

In terms of transportation value, in all 3 groups, transportation tended to occur on the inner surface of the canal curvature at the cervical and middle areas (negative value) and the outer surface of the canal curvature at the apical area (positive value). This is most likely the result of the tendency of the instrument to straighten in a curved canal. Although the RR and MR groups did vary significantly in transportation value at the cervical, middle, or apical level, the MC group varied from the RR and MR groups significantly at the cervical and apical levels, respectively.

These results indicate that Mtwo used in a reciprocating motion was not significantly different from Reciproc, but Mtwo used in a continuous rotating motion caused significantly more transportation. The measured transportation values in this study were similar in range to those of other studies that used similar analysis methods (20, 21, 26). Wu et al (3) stated that apical transportation exceeding 0.3 mm could cause problems in root canal sealing. In this study, a transportation value exceeding 0.3 mm was not observed, except in the cervical area of the MC group.

In a previous study in which 3 Flexmaster files (VDW) were used serially in a continuous rotating motion, transportation occurred much more at the outer part of the canal curvature at the apical third level than when a reciprocating motion was used (23). Other studies comparing the degree of transportation or centering ratio of continuous rotating versus reciprocating motion using conventional NiTi file systems reported no differences between these 2 methods (20, 21, 24, 27). Unlike previous studies in which serial filing was performed in the continuous rotating group, a single file was used in this study for the continuous rotating group (MC group).

According to scanning electron microscopic analysis, the MC group exhibited the greatest file deformation. This corresponds with the results of prior studies stating that when a reciprocating motion is used, instrument fracture or deformation is less likely to occur as opposed to when a continuous rotating motion is used (13-15, 28-30). The reciprocating motion is thought to prevent file binding and, thus, reduce torsional stress on the instrument, which explains why the RR and MR groups exhibited less instrument deformation. Moreover, Reciproc (RR group) exhibited less deformation than Mtwo (MC and MR groups), likely because Reciproc, which is constructed of Mtwo and specially heat-treated M-wire with a short pitch length, is more resistant against torsional deformation (31). Also, the reason why more file deformations occurred in MC group than in the other two groups is thought to be because it was continuous rotating motion that had been used in canal shaping. When canal shaping is performed in continuous rotating motion, there is no process where file gets released from canal wall. However, when using reciprocating motion, the process of file preparing the canal wall and the process of file getting released happens alternately. Therefore, it is known that torsional deformation due to taper lock diminishes (13, 16).

There was no significant difference in canal shaping time between the 3 groups. The recording method and measured time values were similar to those established in previous studies (15, 26, 32). Mtwo, although it was not a file system developed for use in a reciprocating motion, showed similar canal shaping time compared with Reciproc. In the case of the RR group, because 150° counterclockwise and 30° clockwise direction rotations were used, 1 cycle advanced 120°, and 3 cycles were necessary for a complete 360° rotation. In the same manner, the MR group also rotated 360° over 3 cycles. One might think that the MC group would advance faster because only 1 rotation direction is used; however, the canal shaping speed was not faster in the continuous rotation (MC) group, possibly because there was no process instrument release, as seen in the reciprocating motion.

Meanwhile in this experiment, instead of using Mtwo as instructed by the manufacturer in the MC group, the entire canal was shaped in a continuous rotating motion by 1 single instrument. This method was used so that Mtwo use with a reciprocating motion and the conventional continuous rotating motion could be compared directly. As a result, it is assumed that when shaping a canal using Mtwo, a conventional NiTi file, it is not acceptable to use a single instrument to shape the whole canal in a continuous rotating motion, but using it in a reciprocating motion might be possible to some extent.

According to a previous study using conventional rotary NiTi file systems Profile and RaCe (FKG Dentaire, La-Chaux-de-Fonds, Switzerland), a reciprocating motion could be a potential alternative for the continuous rotary shaping technique (24). However, fracture resistance, another significant factor, must be considered and requires further investigation. Moreover, there is little information on the optimal reciprocating angle and speed for conventional file use, and this should also be studied in future research.

Another point to consider is the fundamental problem of the single-file reciprocating technique. The single-file system is attractive because of its reduced canal shaping time, low cost, prevention of cross-contamination, and easy clinical application, among other reasons. The reciprocating motion itself has merit in that it significantly raises cyclic fatigue resistance compared with the continuous rotation method; however, in some studies in which the single-file reciprocating technique was used, canal shaping was not superior to that of the conventional multifile continuous system in oval-shaped canals and isthmus debris cleaning (33-35). Another study reported that when a single-file reciprocating technique was used, more canal debris accumulated compared with when the conventional multifile continuous system was used (29, 36). The multifile reciprocating technique might be considered to be another alternative.

In this study, the canal shaping abilities of Reciproc, a reciprocating file system, and Mtwo, a conventional NiTi file system morphologically similar to Reciproc, were analyzed using micro-CT imaging. The use of Mtwo in a reciprocating motion exhibited similar results to those of Reciproc. When Mtwo was used in a continuous rotating motion, more transportation occurred than when used in a reciprocating motion. From the perspective of shaping ability, Mtwo, a conventional NiTi file system, may be used in a reciprocating motion.

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Table 1. Cross sectional diameters and tapers of Reciproc R25 and Mtwo 25.07 from manufacturer

L(mm)	Reciproc R25		Mtwo 25.07	
	taper(%)	⌀(mm)	taper(%)	⌀(mm)
0		0.250		0.250
1	8.0	0.330	7.0	0.320
2	8.0	0.410	7.0	0.390
3	8.0	0.490	7.0	0.460
4	6.5	0.555	7.0	0.530
5	6.0	0.615	7.0	0.600
6	5.5	0.670	7.0	0.670
7	5.0	0.720	7.0	0.740
8	5.0	0.770	7.0	0.810
9	5.0	0.820	7.0	0.880
10	4.0	0.860	7.0	0.950
11	4.0	0.900	7.0	1.020
12	3.0	0.930	7.0	1.090
13	3.0	0.960	7.0	1.160
14	3.0	0.990	7.0	1.230
15	3.0	1.020	7.0	1.300
16	3.0	1.050	7.0	1.370

L: distance from the end of the instruments, ⌀: cross sectional diameters

Table 2. Root canal curvature, root canal volume, and root canal surface area of 3 groups before instrumentation

Group	Root canal curvature(°), mean ± SD	Root canal volume(mm^3), mean ± SD	Root canal surface area(mm^2) mean ± SD
RR	25.40±1.49	1.64±0.30	34.19±3.99
MR	24.67±1.58	1.29±0.24	31.13±3.06
MC	23.07±1.08	1.22±0.30	33.01±7.47

MC group, Mtwo used in a continuous rotating motion ; MR group, Mtwo used in a reciprocating motion ; RR group, Reciproc used in a reciprocating motion ; SD, standard deviation.

Table 3. Root canal preparation time

Group	n	Preparation time(s) mean±SD
RR	15	80.67±0.88
MR	15	71.47±4.07
MC	15	74.20±4.30

MC group, Mtwo used in a continuous rotating motion ; MR group, Mtwo used in a reciprocating motion ; RR group, Reciproc used in a reciprocating motion ; SD, standard deviation.

Table 4. Changes of root canal volume of the canals after root canal preparation

Group	Pre-instrumentation(mm^3) mean±SD	Post-instrumentation(mm^3) mean±SD	Volume Changes(mm^3) mean±SD
RR	1.64±0.31	2.43±0.29	0.79±0.14
MR	1.29±0.24	2.66±0.20	1.37±0.18
MC	1.22±0.31	2.35±0.32	1.13±0.17

MC group, Mtwo used in a continuous rotating motion ; MR group, Mtwo used in a reciprocating motion ; RR group, Reciproc used in a reciprocating motion ; SD, standard deviation.

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Table 5. Transportation value of the canals after root canal preparation

	RR group(mm)	MR group(mm)	MC group(mm)
Cervical third	0.011	-0.072	-0.561
	0.024	0.012	-0.114
	0.018	0.153	-0.379
	-1.195	-0.057	-0.065
	-0.114	0.098	-0.073
	-0.159	-0.194	-0.358
	0.010	0	-0.646
	-0.023	0.268	-0.094
	-0.228	-0.233	-0.529
	-0.104	-0.012	-0.308
	-0.096	-0.559	-0.384
	0.145	-0.413	-0.564
	-0.145	0.048	-0.48
	0.219	0.004	-0.332
	-0.047	-0.218	-0.387
Middle third	-0.246	-0.035	-0.05
	-0.198	0.002	0.008
	-0.192	0.006	0.108
	-0.003	-0.146	-0.001
	-0.022	-0.252	-0.097
	-0.116	0.024	0.265
	-0.25	-0.144	-0.097
	-0.023	-0.242	-0.001
	-0.248	0.023	-0.097
	-0.159	0.073	-0.187
	0.023	0.072	-0.068
	-0.047	-0.025	-0.122
	0.121	0.048	-0.316
	-0.122	0.022	-0.422
	-0.096	-0.121	-0.048

Apical third	0.199	-0.049	0.234
	0.108	0.097	0.131
	-0.024	-0.05	0.166
	0.028	-0.027	0.115
	0.068	0.15	0.255
	-0.023	-0.098	0.095
	0.137	-0.024	0.143
	-0.068	0.049	0.18
	-0.024	0	0.146
	0.138	-0.121	0.188
	0.122	0.073	0.214
	0.169	0.23	0.344
	0.29	-0.048	0.128
	-0.025	0.137	0.115
	-0.048	-0.074	0.656

MC group, Mtwo used in a continuous rotating motion ; MR group, Mtwo used in a reciprocating motion ; RR group, Reciproc used in a reciprocating motion ; SD, standard deviation.

Table 6. Mean transportation value of the canals after root canal preparation

	RR group(mm) mean ±SD	MR group(mm) mean ±SD	MC group(mm) mean ±SD	p value
cervical third	−0.11±0.08[a]	−0.07±0.06[a]	−0.35±0.05[b]	0.008
middle third	−0.10±0.03	−0.04±0.03	−0.08±0.04	0.466
apical third	0.07±0.03[a]	0.02±0.03[a]	0.20±0.04[b]	0.000

MC group, Mtwo used in a continuous motion; MR group, Mtwo used in a reciprocating motion; RR group, Reciproc used in a reciprocating motion; SD, standard deviation

Different subscript letters in the same column indicate a significant difference at $p < .05$.

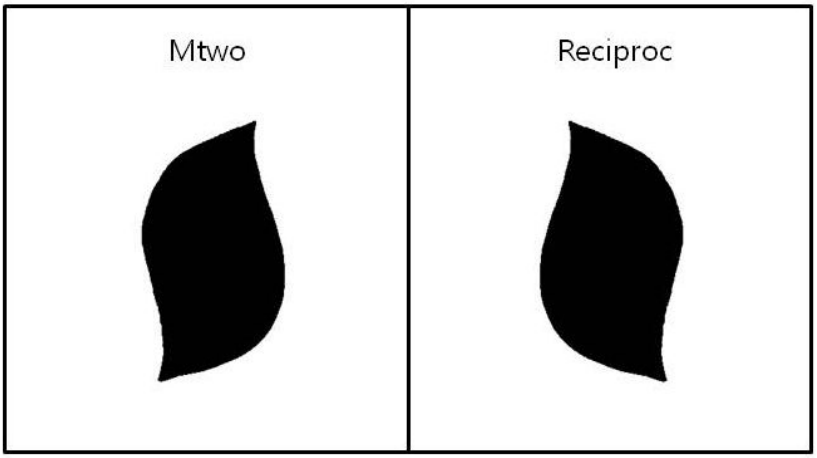

Figure 1. S-shaped cross-sectional design of Mtwo and Reciproc : They are mirror images of each other.

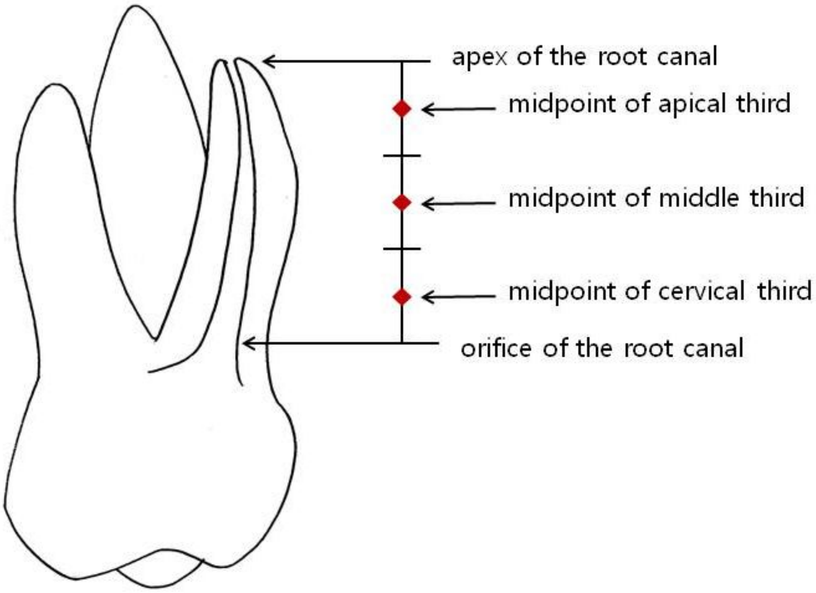

Figure 2. Diagram indicating the measuring spots of transportation value(◆)

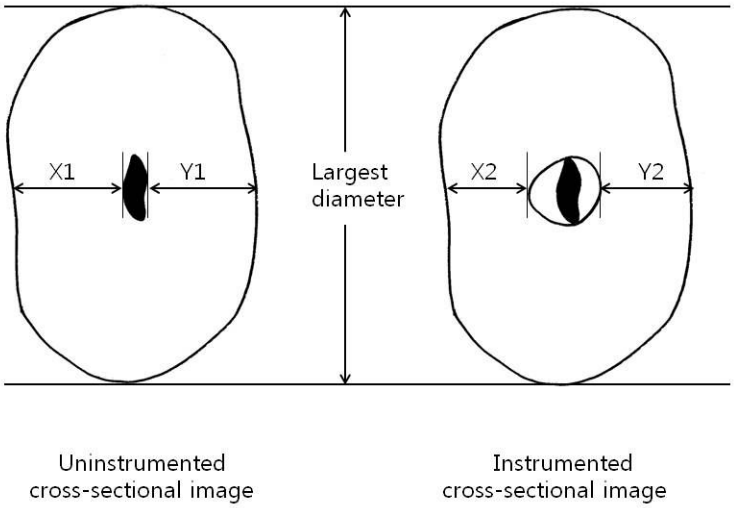

Figure 3. Diagram showing the measuring method of transportation value

* Transportation value = (X1-X2)-(Y1-Y2)

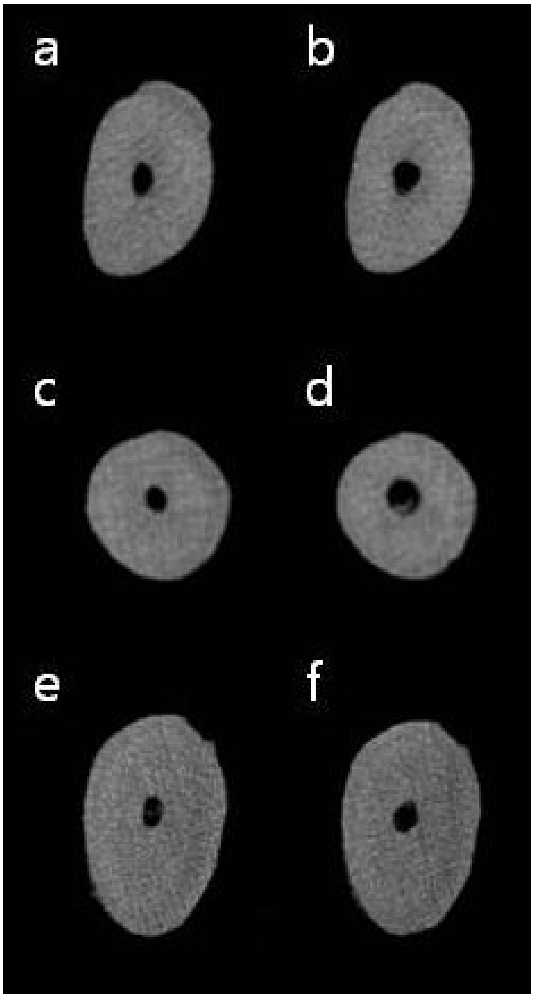

Figure 4. Cross sectional micro-computed tomography images before(a,c,e) and after(b,d,f) canal preparation at 3mm level from the apical foramen. (a,b: RR group; c,d: MR group; e,f: MC group)

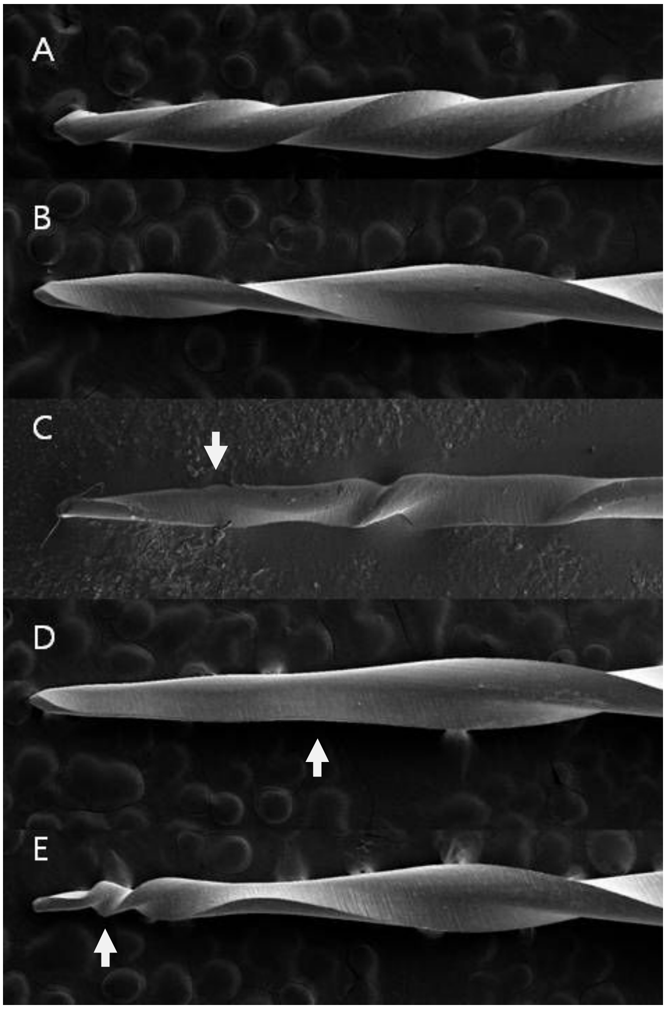

Figure 5. The scanning electron microscopic view of the file surface after completing canal preparation (30x). (A) Intact Reciproc R25 (RR group), (B) intact Mtwo (MR group), (C) Reciproc (RR group) showing unwinding (arrow) of the helical structure, (D) Mtwo (MR group) showing unwinding (arrow) of the helical structure, and (E) Mtwo (MC group) showing twisting (arrow) the helical structure.

-국문 초록-

미세 전산화 단층 촬영술을 이용한 Reciproc 파일과 일방 회전식 및 양방 회전식으로 사용한 Mtwo 파일의 근관 성형능 비교 연구

서울대학교 대학원 치의학과 치과보존학 전공

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목 적

이 실험의 목적은 양방 회전식 니켈-티타늄 전동 파일인 Reciproc (VDW, Munich, Germany)의 근관 성형능과 이와 형태학적으로 유사한 일방 회전식 니켈-티타늄 전동파일인 Mtwo (VDW)을 양방 회전식으로 사용한 경우 근관 성형능을 미세 전산화 단층 촬영술을 이용하여 분석 비교하는 것이다.

방 법

발치된 상악 대구치의 근심 협측 근관과 원심 협측 근관 45 개를 3 개의 군으로 나누어 근관 형성하였다. RR 군은 Reciproc 파일을 양방 회전식 (반시계 방향으로 150 도, 시계 방향으로 30 도, 분당 300 회전)으로 MR 군은 Mtwo 파일을 양방 회전식 (시계 방향으로 150 도, 반시계 방향으로 30 도, 분당 300 회전)으로, MC 군은 일방 회전식 (분당 300 회전)으로 적용하였다. 근관 형성

전후의 미세 전산화 단층 촬영 영상으로부터 근관 부피의 변화와 근관 변위 (transportation) 정도를 치근의 치경부, 중앙부, 근단부 수준에서 측정하고 근관 성형에 소요된 시간을 기록하였다. 근관 성형 완료 후 각 파일의 변형 정도를 주사 전자 현미경으로 분석하였다. 3 개 군의 근관 성형 시간과 근관 부피 변화 및 근관 변위 정도를 일원 배치 분산 분석법을 이용하여 통계 분석하였다. ($p<0.05$)

결 과

각 군의 근관 성형에 소요된 시간과 근관 성형 전후 근관 부피의 변화량은 3 개 군간에 통계적으로 유의한 차이를 보이지 않았다. ($p>0.05$) 근관 변위 정도는 RR 군과 MR 군에서는 치근의 치경부, 중앙부, 근단부 모든 수준에서 통계적으로 유의한 차이를 보이지 않았으나, MC 군은 치근의 치경부와 근단부 수준에서 RR 군 및 MR 군과 각각 유의성 있는 차이를 보였다. ($p<0.05$) 주사 전자 현미경 관찰 결과 RR 군에서 1 개, MR 군에서 3 개, MC 군에서 5 개의 파일에서 변형이 관찰되었다.

결 론

만곡 근관에서 전통적인 일방 회전식 니켈-티타늄 전동 파일인 Mtwo 를 양방 회전식으로 사용한 경우 근관 성형능과 성형 시간은 양방 회전식 니켈-티타늄 전동 파일인 Reciproc 을 사용한 경우와 유의한 차이를 보이지 않았다.

주요어 : 미세 전산화 단층 촬영, 양방 회전식, 일방 회전식, 니켈-티타늄 파일, 근관 성형능

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