

The Effectiveness of Obturating Techniques in Sealing Isthmuses

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국문초록

근관충전방법에 따른 근단부 isthmus의 폐쇄효과에 관한 비교연구

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불완전하게 충전되거나 충전이 되지않은 isthmus는 다근치에 있어서 근관치료의 높은 실패율을 나타낸다. 따라서 본 연구의 목적은 isthmus를 갖는 근관을 골라 근관계의 기구조작을 시행하고 여러 가지 근관충전 방법을 이용하여 근관을 충전한 다음 근단부 형성시 적절한 파일의 크기와 치근단부의 밀폐효과를 각 부위별로 비교평가 해보고자 하는 것이다.

Isthmus를 갖는 66개의 발거한 치아를 대상으로 기구조작을 통하여 근관확대를 완성하고 무작위로 각각 20개씩 3군으로 분류한 다음 아래와 같은 방법으로 근관을 충전하였다. : A군 측방가압충전법으로 충전한 군, B군 Continuous wave 충전법으로 충전한 군, C군 MicroSeal™을 이용하여 충전한 군.

나머지 6개의 치아는 3개씩 양성대조군과 음성대조군으로 정하였으며 기구조작 후 근관은 충전하지 않은 채로 두었다.

대조군을 제외한 모든 군은 각각 제조회사의 지시에 따라 근관충전한 후 각 시편의 치근단부 2mm를 제외하고 나머지 부위는 두겹의 nail polish를 발라주었으며 2% methylene blue염색에 침잠시켰다. 일주일 후 꺼내어 흐르는 물에 깨끗이 세척한 다음 치근단 부위에서부터 1mm씩 잘라가면서 20배의 배율에서 염색액의 침투정도를 평가하였다.

염색액의 침투정도는 다음과 같이 평가되었다. : A군과 B군에서는 많은 수의 시편에서 4mm 이상의 절단면에 염색액의 침투를 보인 반면 C군에서는 단지 3mm 절단면에서 총 20개 중 3개의 시편에서 염색액의 침투를 보였을 뿐 그 이상의 절단면에서는 염색액의 침투를 보이지 않았다. 뿐만 아니라 isthmus를 갖는 제2형 근관계의 근단부 형성은 40번 크기보다는 큰 MAF가 요구되는 것으로 나타났다.

이러한 결과를 비추어볼 때 isthmus를 갖는 다근치에서 근관충전시 적어도 40번 이상의 MAF로 근단부 형성을 한 후, 열가소성 Continuous wave 충전법과 MicroSeal™을 이용한 근관충전법이 기존의 측방가압충전법 보다는 효과적인 것으로 나타났다.

I. INTRODUCTION

The most common cause of endodontic failure is incomplete obturation of the root canal⁷⁾. The root canal system has many variations in anatomy, such as irregularly shaped canals, lateral and accessory canals, anastomoses between canals and a variety of

fins. For these reasons, It is difficult to prepare the canals to a form conducive to complete obturation with filling materials.

Weine et al.^{13,14)} defined a Type II canal configuration as two separate canals that merged short of the apex to form a single exit. Pineda⁹⁾ reported interconnections in 4.9% of the roots examined, and

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Vertucci²⁰ reported the Type II configuration in 37% of the mesiobuccal roots of the maxillary first molar and he found the highest percentage of an isthmus(52%). He also reported that 75% of the anastomoses were located in the middle and 15% were in the apical third of the root.

We encounter isthmus areas many times especially in molar surgery.

Friedman et al.³ reported the success rate of endodontic treatment was only 44.1% of the premolars and molars treated. However, success rate in anterior teeth was reported to be as high as 85 to 90%⁷.

If a root resection becomes necessary in a Type II canal, it is possible that the unfilled canal will be exposed to the periapical environment and will allow for the retention of tissue fluids, debris and microorganisms, thus increasing the chances of endodontic failure.

Also, Schilder¹¹ reported five mechanical objectives for successful cleaning and shaping. To clean and predictably seal the foramen, the size of the file used at the end of the cleaning and shaping should be at least a No. 20 or 25 in the ISO size.

However, another study has shown that for root canals to be effectively irrigated, they should be enlarged to at least the size of a No. 40 file⁹.

As above, many studies have been reported on the right size of apical preparation in many types of root canals.

But the proper size for apical preparation in Type II root canals with isthmuses has not been decided yet and it is still controversial.

Therefore, the purpose of this study was to evaluate the proper size of apical preparation and effectiveness of obturating techniques for sealing isthmus

es at different levels from the apex in Type II root canals with isthmuses.

II. MATERIALS AND METHODS

Sixty six human extracted molars with a Type II configuration that has 2 orifices and canals that join short of the apex to form one canal, were selected through the radiograph and stored in normal saline. The age, sex and race of the patients were unknown. The crown portions of all teeth were resected at the cemento enamel junction with a diamond saw. A size 10 K file was introduced into the root canals to determine the working length and check the Type II configuration by taking a radiograph. The working length used was 0.5mm short from the anatomical apex.

All canals were instrumented by the combined preparation technique(Hybrid technique) using 3 different kinds of rotary instruments. The orifice shaper(ProFile, Tulsa Co. U.S.A.) was used to flare the coronal third of the root canal at 340rpm and the Quantec #1(Tycom Co. U.S.A.) was used for merging the preparation at the mid portion of the root canal at 340rpm. Finally, the size 40 LightSpeed[®](LightSpeed Co. U.S.A.) were used for apical 3mm preparation at 750rpm. All instrumentations followed the manufacturer's recommendations and all root canals were irrigated with 2.5% sodium hypochlorite during instrumentation. After finishing the instrumentation, all root canals were soaked with EDTA for 10 minutes and dried before obturation.

The prepared roots were randomly divided into three groups of 20 teeth each, positive and negative control groups of three teeth each(Table 1). All experimental groups used gutta percha and AH

Table 1. Group Classification

Group	No. of Teeth	Obturating Instruments	Obturation Method
Positive Control	3		-
Negative Control	3		-
Group A	20	Finger Spreader	Cold Lateral
Group B	20	System B, Obtura II	Continuous wave
Group C	20	MicroSeal [™]	Thermo-mechanical Compaction

26 (root canal sealer, Dentsply Co. U.S.A). Group A was obturated by the cold lateral condensation technique, Group B by the Continuous wave technique and Group C by the Thermo mechanical compaction technique using MicroSeal™ (Tycom Co. U.S.A). The positive and negative control groups were left without obturation.

In Group A, we used a size 40 master cone, a size 25 finger spreader and fine fine accessory cones.

In Group B, we used the Continuous wave obturation technique suggested by Buchanan⁹ followed by Obtura II (Obtura Co. U.S.A) backfill. We pre fitted a Buchanan's plugger, a Schilder's plugger and an Obtura II tip all to 3mm short from the working length. The size 40 customized master cone was made using the gutta percha gauge and inserted into the root canal with sealer. Then the pre fitted Buchanan's plugger was activated by the System B (Analytic Tec. U.S.A) and inserted into the root canal for obturating the apical 3mm according to the Continuous wave obturation technique. Then the Schilder's plugger was inserted steadily at the 3mm level for vertical condensation. Next, the Obtura II was used for backfill at 200°C.

In Group C, a size 40 MicroSeal™ customized master cone was inserted into the root canal with sealer. Then the size 25 MicroSeal™ spreader was inserted 1mm short from the working length. After that the coated MicroSeal™ condenser was carried immediately into the root canal and then the rotation started at 6,000rpm using a 1 : 1 handpiece. After obturation, we took a radiograph to verify the Type II canal configuration (Fig. 1).

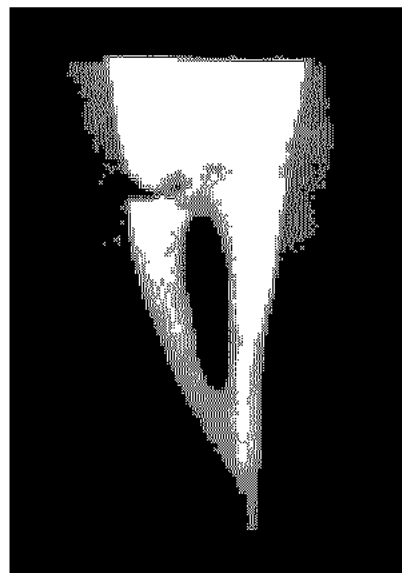
All the samples except the negative controls were coated with two layers of nail polish, except the apical 2mm that were left exposed, but all root surfaces of the negative controls were coated with nail polish. After the nail polish dried, the apical 5mm of the root were immersed in 2% methylene blue for 7 days at room temperature.

Afterward, the teeth were rinsed under tap water to remove the Methylene Blue on the external root surface. Each root was embedded individually in yellow stone mold for serial transverse sections.

These teeth were cross sectioned to 5 levels of 1mm increments from the anatomical apex with the low speed diamond saw (Buehler Ltd., Evanston, U.S.A). The serial sections of each root were



W-L radiograph



Final radiograph

Fig. 1. Verify the Type II root canal configuration

- Score 1: Dye penetration at bottom side of Level 1
- 2: Dye penetration at bottom side of Level 2
- 3: Dye penetration at bottom side of Level 3
- 4: Dye penetration at bottom side of Level 4
- 5: Dye penetration at bottom side of Level 5

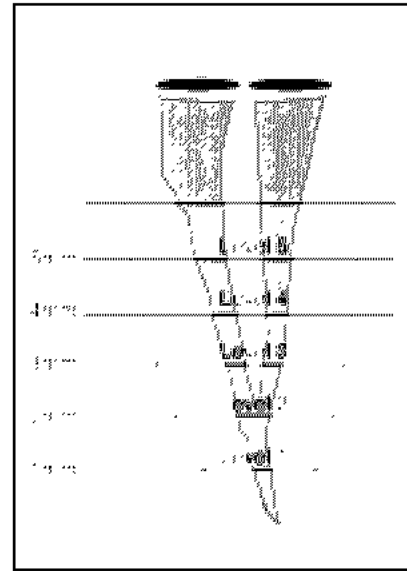


Fig. 2. Scoring System

arranged from the 1mm level to the 5mm level on glass slides and three investigators examined the bottom side of the section with a surgical operation microscope(Global Ins. U.S.A) at 20X magnification and photographs were taken for image analysis.

In this study, we used a scoring system. When a sample only showed dye leakage at level 1, but it didn't show any leakage from level 2, the score of this sample was 1. In this way, we gave a score from 1 to 5(Fig. 2).

A complete isthmus was one with a continuous, narrow opening between the two main root canals. A partial isthmus was classified as an incomplete communication with one or more patent openings, through the section, between the two main canals¹⁹.

In this study, we evaluated the dye leakage scores according to the isthmus shapes with photographs were taken for image analysis.

Also, we evaluated the dye leakage scores according to the shape of apical preparation around filling materials with round or fin shape. The statistical comparison of the mean leakage score at each level was done with the Kruskal Wallis nonparametric analysis among three groups, and followed by the Mann Whitney test to evaluate differences between specific groups at the p=0.05 level.

III. RESULTS

The positive controls(three teeth) allowed total dye leakage through the root canal while the negative controls(three teeth) showed no dye leakage.

Table 2 showed the mean leakage score of each group. The MicroSeal™ Group (Group B) showed the lowest score among the three groups, and there was a significant difference among the three groups by the Kruskal Wallis test, and there was a significant difference between only Cold lateral Group (Group A) and the MicroSeal™ Group (Group C) by the Mann Whitney test(p<0.05)

(Table 2, Fig. 3).

Table 3 showed the number of samples with maximum leakage at each level. The Cold lateral Group (Group A) showed dye leakage up to the 4mm level. However, in the MicroSeal™ Group(Group C), only six teeth out of 20 showed dye leakage at the 3mm level and none in higher levels(Table 3, Fig. 4).

Also, Figure 5 showed the total number of samples with maximum leakage at each level. Twenty four teeth out of 60 showed maximum leakage at level 3. While the number of samples was increased until level 3, it decreased in higher levels(Fig. 5).

In image analysis, the samples with a complete isthmus were better sealed than the samples with a

Table 2. The mean leakage score of each group

Group	Sum	Mean	S.D.	S.E.
Cold Lateral	59	2.95	1.191	0.266
* [Continuous wave @]	48	2.40	0.883	0.197
MicroSeal™	41	2.05	0.759	0.170

* Statistically significant(p<0.05) by Kruskal-Wallis test

@ Statistically significant(p<0.05) by Mann-Whitney test

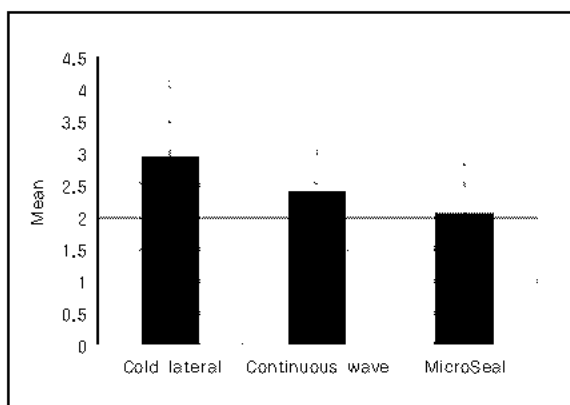


Fig. 3. The mean leakage score of each group

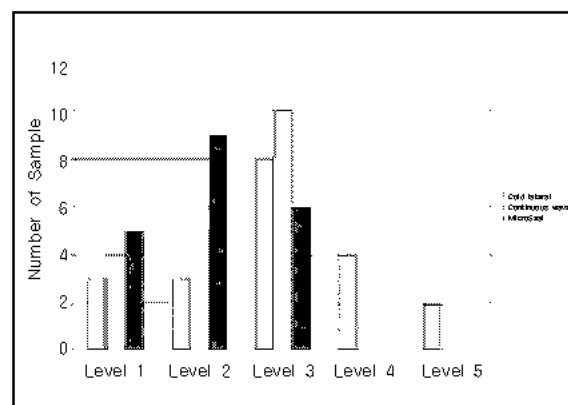


Fig. 4. The number of samples with maximum leakage at each level

Table 3. The number of samples with maximum leakage at each level

Group	Level	1	2	3	4	5	Sum
	Cold Lateral		3	3	8	4	2
Continuous wave		4	5	10	1	0	20
MicroSeal™		5	9	6	0	0	20
Sum		12	17	24	5	2	60

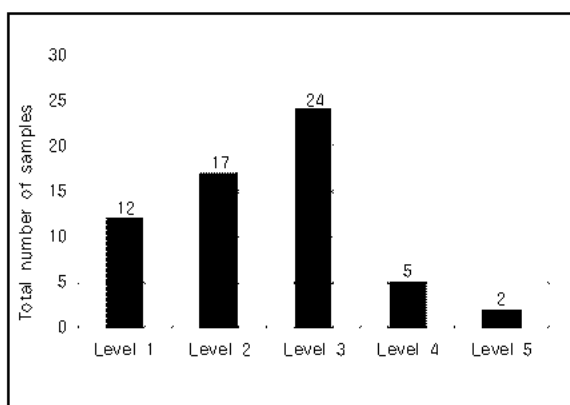
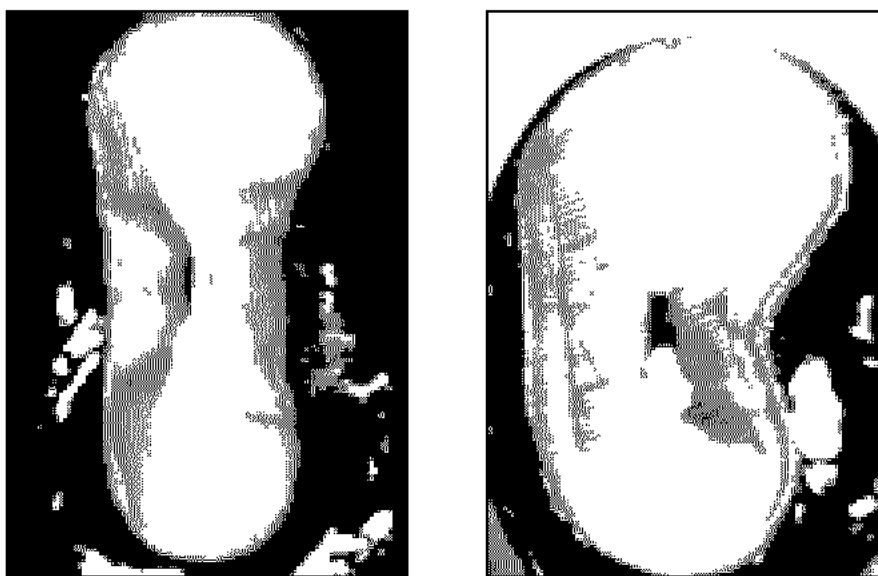


Fig. 5. Total number of samples and leakage levels

partial isthmus(Fig. 6). Seven out of 60(11.7%) showed the complete isthmuses and the mean leakage score was 1.87 while the partial isthmuses were fifty three out of 60(88.3%) showed the mean leakage score was 2.54, and there was a significant difference in mean leakage score between complete isthmus and partial isthmus by the Mann Whitney test(p<0.05).

Also, regardless of the presence of the isthmus the perfect apical round preparation provided a good seal. Twenty one out of 60, about 35%, showed the apical round preparation and the mean leakage score



Complete Isthmus

Partial Isthmus

Fig. 6. Image analysis of each sample

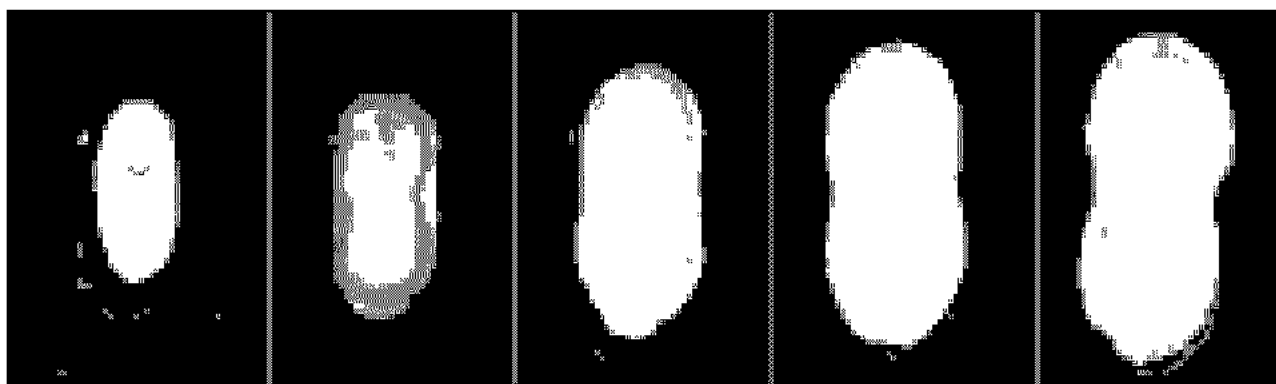


Fig. 7. Image analysis Apical round preparation

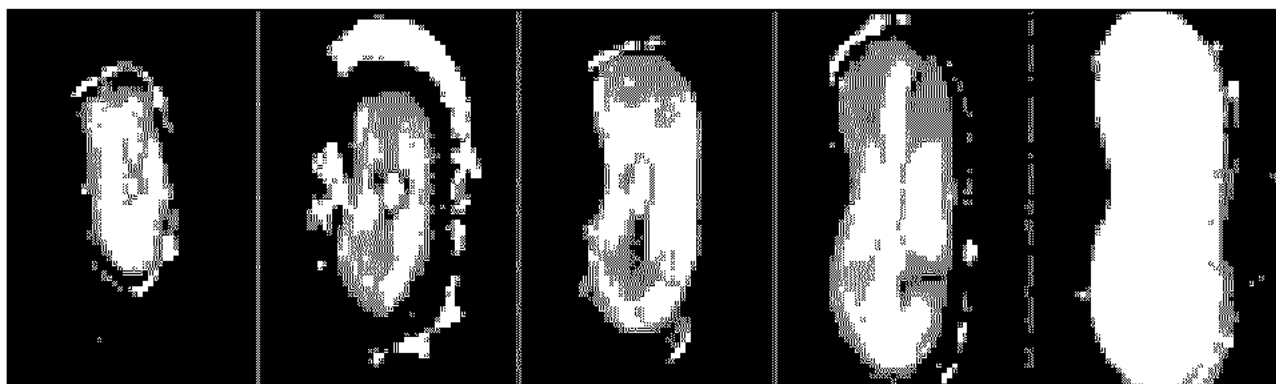


Fig. 8. Image analysis Fin or deviation from the round preparation

was 1.66(Fig. 7).

However, the leakage was significant when there was a fin or any deviation from the round preparation at the apex. Thirty nine teeth out of 60, about 65%, showed the fin or deviation after instrumentation and the mean leakage score was 2.9(Fig. 8). And, there was a significant difference in mean leakage score between round apical preparation and fin from the round preparation by the Mann Whitney test($p < 0.05$).

IV. DISCUSSION

Several reports have been published about root canal morphology. The types of root canals and configurations were reported by Weine et al.⁴, Vertucci¹² and Caliskan et al.². Weine et al.^{13,14} defined a Type II configuration as a larger buccal canal and a smaller lingual canal that merge from 1 to 4mm from the apex. Vertucci¹² found that 37% of the mesiobuccal roots of the maxillary first molar to be Type II canal configurations, whereas Caliskan et al.² found it to be about 41%.

However, there were few studies about isthmuses. Weller et al.¹⁵ found the incidence of isthmuses was highest in the apical 3 to 5mm levels in the mesibuccal root of the maxillary first molar. In the case of mesiobuccal roots that had two canals, they found the complete isthmuses to be about 12% and the partial isthmuses about 88% at the 4mm level.

In this study, we used the Type II canal configuration that had 2 orifices and canals that joined short of the apex to form one canal, because it might have an isthmus at the joining portion.

In image analysis, we found that the incidence of complete isthmus was 11.7%, partial isthmus was 88.3%(Fig. 6). Also, we found that the incidence of isthmuses, either complete or partial, were highest in the 3 to 4mm level and this result was similar to Weller's study(Fig. 7, 8).

In our study, twenty four teeth out of 60 showed the maximum dye leakage at level 3. While the numbers of the teeth were increased until level 3, it were decreased in higher levels(Table 3, Fig. 5). This is important because, when a root is surgically resected, the isthmus may still exist at the resected root

surface. If that happens, then the untreated isthmus could contribute to the failure of the case unless identified and sealed with a retrograde filling. These results indicate that the presence of an isthmus must be assumed and the isthmus area should always be prepared and sealed with a retrofilling at least 3mm from the root apex⁸.

Several reports have been published examining the sealing ability of various thermoplasticized gutta percha techniques. Most of them used single rooted teeth and dyes such as methylene blue or India ink as the tracer. In this study, we used human molar teeth that had the Type II canal configuration by taking a radiograph and methylene blue to estimate linear dye leakage from the root apex. The mean leakage scores of Group B(Continuous wave) and C(MicroSealTM) were much lower than Group A(Cold lateral condensation)(Table 2, Fig. 3). Hata et al.⁶ and Goldberg et al.⁴ reported that there was no statistically significant differences between lateral condensation and thermoplasticized gutta percha techniques when they used single rooted teeth in their research. These results were different from our result because we used the molar teeth that had the isthmus area. The isthmus area was difficult to prepare and a obturate if located.

Now, we are able to see the isthmus area on the resected root surface better with surgical operating microscope. On the other hand, Reader et al.¹⁰ used epoxied blocks with a single root canal and five lateral canals and they reported that the warm obturation techniques had significantly more gutta percha in the lateral canal. This result was similar to our findings. Therefore, we can use the thermoplasticized gutta percha techniques in case of the isthmus canals.

In addition to that, we found that perfect apical round preparation provided a good seal(Fig. 7). When there was a fin or any deviation from the round preparation at the apex, the dye leakage was much higher than the perfect apical round preparation(Fig. 8). Even though we used a size 40 LightSpeed[®] for an apical 3mm preparation, there were still remaining fins or deviations around the round preparation. These results indicated that the master apical rotary with a size 40 file was not sufficient in the Type II root canal with isthmuses, sug

gesting that the master apical rotary must be larger than size 40 to get the perfect apical round preparation.

V. CONCLUSION

The MicroSeal™ technique obturated multirooted teeth with isthmus more effectively than the cold lateral condensation technique which was statistically significant ($p < 0.05$), but the effectiveness of the MicroSeal™ technique was not statistically significant when compared with the Continuous wave technique.

In many situations, master apical file with No. 40 file was not sufficient in the Type II root canals with isthmuses, suggesting that the master apical file must be larger than No. 40 in the ISO size.

These results seem to indicate that the MicroSeal™ and Continuous wave techniques after enlarging the root canals with at least No. 40 MAF obturate more effectively than the Cold lateral condensation technique in case for the multirooted teeth with isthmuses.

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