

## Endodontic Retreatment using 3Mix-MP without Removal of Previous Root Canal Obturation

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### Abstract

This is a retrospective clinical study of 161 permanent teeth that needed retreatment because the previous treatment failed. Pre-operative X-ray photos showed radiolucent periradicular lesions in all the cases. The re-treatment was carried out using 3Mix-MP without removing previous root canal obturation. A ball-like particle (1 mm diameter) of standard preparation of 3Mix-MP was placed and pressed onto previous obturation at the orifice of root canals, sealed by glass-ionomer cement and restored by resin inlays. A good clinical outcome was defined as the lack of any mechanical allodynia to biting and the disappearance or reduced sizes of radiolucent alveolar bone resorption, and without any other clinical symptoms. Using these criteria, a good clinical outcome was found in 158 cases. Remaining 3 cases were also good after giving a re-restoration to ensure tight sealing. These data suggest that 3Mix-MP may be worth evaluating in prospective randomized clinical trials for root canal re-treatment including cases of so-called "repeated recurrent periapical disorders".

### Key words:

3Mix-MP, endodontic retreatment, LSTR, NIET, radiolucent lesions

### Introduction

It is possible for bacteria residing in oral cavity to come into caries lesions when caries cavity opens to oral cavity. Such bacteria may invade into pulp tissue causing pulpitis, and, then, periapical disorders. Thus, any oral bacteria are possible to cause endodontic disorders (1-5).

It may not be so rare that such bacteria remain in endodontic lesions even after endodontic treatment, causing recurrent endodontic disorders. In addition, recurrent endodontic disorders may be caused by bacteria that invade newly through micro-leakages around the restoration, although non-bacterial causes such as traumatic occlusion may also be associated with the recurrent clinical symptoms. Recently tooth-fracture happens in some cases after root canal treatment, and bacteria may invade through the fracture to root canal system, causing also recurrent endodontic disorders.

Using the conceptual framework that any kinds of oral bacteria have possibly cause endodontic disorder including recurrent ones after the previous endodontic treatment, bacterial constituents of carious dentin (1), pulpitis lesions (3), infected root dentin and necrotic pulps (2, 4), periapical lesions and infected cementum (5) have been analyzed under strict anaerobic conditions to understand which bacteria are present in these lesions. In addition, bacteria at other oral sites, including dental plaque (6), tongue plaque (7), denture plaque (8), saliva (9), periodontal pockets (10) and osteomyelitis sites (11) have been also analyzed with strict anaerobic procedures because these were possible sources of bacteria invading endodontic lesions. These studies included a large number of the "difficult to culture" species of bacteria (12). Importantly, all of these bacteria were found to be sensitive against a combination of three antibacterial drugs (3Mix), namely ciprofloxacin, metronidazole and minocycline (5, 13-21), together with other combinations (17). In addition, when was mixed with macrogol (M) and propylene glycol (P), the combination has been demonstrated to penetrate efficiently dentinal lesions via dentinal tubules (22) and through previous endodontic obturation (23), suggesting that bacteria in

endodontic lesions could be killed by placement of 3Mix-MP at the bottom of a carious lesion or on the previous root canal obturation. Thus, one important prediction of the LSTR hypothesis is that local delivery of effective antibiotics in an appropriate vehicle to endodontic lesions may lead to healing of cases of recurrent endodontic disorders without a need for conventional re-instrumentation and re-filling procedures.

The aim of this retrospective clinical study was to evaluate the clinical outcomes of this hypothesis by following up endodontic retreatment cases using local application of 3Mix-MP, which is called as "LSTR 3Mix-MP NIET therapy" (21, 24-25) and, NIET means "Non-instrumentation endodontic treatment".

### Materials and Methods

#### *Patients and teeth involved in this study*

A total of 161 teeth involved in this study. The patients, aged from 19 to 78 years old, visited one of the clinics of Drs. Takushige, Hataoka and Ando, Sendai, Japan, because their previous endodontic treatments done elsewhere have failed. Prior to their inclusion to this study using LSTR 3Mix-MP therapy, they were informed of the aim, expected clinical results, as well as the risks and alternative conventional treatment, and they subsequently completed an approved informed consent, although most of them would keenly like to be obtain LSTR 3Mix-MP endodontic therapy after they have recognized the previous treatment had failed.

Root canals of all the cases had been previously obturated.

#### *Clinical and radiographic observations*

Clinical symptoms, such as swelling, abscess, sinus tract, induced pain on cold and hot conditions, pain on bite, spontaneous pain, were recorded before and after the treatment. Preoperative radiographs were taken prior to treatment to observe conditions of pulp chambers and periodontium. Postoperative radiographs were also taken to observe radiographic changes in periradicular lesions.

### **Preparation of 3Mix-MP**

Commercially prepared chemotherapeutic agents, namely, ciprofloxacin (Ciproxan, Bayer, Osaka, Japan), metronidazole (Trichocide, Green Cross, Osaka, Japan) and minocycline (Minomycine, Ledea-Japan, Tokyo, Japan) were used. Preparation procedures of 3Mix-MP were described elsewhere (21, 24-26). In short, after removal of the capsules or coating materials that enclose the drug products, each of the drugs was pulverized to fine powders using porcelain mortars and pestles, and then stored separately in a tightly capped porcelain container to prevent exposure to light and humidity. A small amount of silica gel in a bag was placed inside the container to maintain low humidity. The powdered drugs were used within a month of preparation. On the day of treatment, powdered ciprofloxacin, metronidazole and minocycline were mixed in a ratio of 1:3:3 (by volume). The vehicle, of an ointment consistency, was prepared separately by mixing macrogol (M; Solbase, Meiji, Tokyo, Japan) and propylene glycol (P) in a ratio of 1:1 (by volume). The 3Mix antibiotics and MP vehicle were thoroughly mixed to form 3Mix-MP in a ratio of 7:1 for standard consistency and, then, ball-like particles (1 mm diameter) of 3Mix-MP were prepared. 3Mix-MP preparation should be prepared and used on the day of preparation.

### **Clinical procedure of LSTR root canal treatment without removal of previous obturation**

The clinical procedures are described elsewhere (24-26). In brief, after previous coronal restoration was removed, a medication cavity was prepared at the orifice of root canal, of which size was 1 mm diameter x 2 mm depth, and the cavity was irrigated with 12% EDTA solution, pH 7.0 to remove smear layers. Previous root canal obturation was left intentionally. The cavity wall and bottom were dried up using a cotton ball or an absorbing paper, and then, a 1 mm diameter ball-like particle of 3Mix-MP was placed onto the bottom of cavity. A care was taken not to leave 3Mix-MP dangling from the edges of medication cavity, but to adhere 3Mix-MP tightly onto the previous root obturation, otherwise 3Mix-MP might not penetrate through the obturation.

A NIET carrier (Japan Dental Supply, Tokyo, Japan) was helpful for placement of the medication. Then, a first layer of glass-ionomer cement (Fuji IX, GC, Tokyo) was applied to seal 3Mix-MP with care not to express 3Mix-MP out of the cavity. The previous restoration cavity was then entirely sealed with the second layer of glass-ionomer cement. Then, a widely open-angled restoration cavity for a composite resin-inlay restoration was made as small in size as possible. The wider margin areas on enamel were provided to reinforce the seal and to ensure sufficient adherence and retention of the composite resin-inlay restoration following etching with 35% phosphoric acid solution. The resin-inlay, made using the Clearfil composite resin (Kuraray, Tokyo, Japan) on the tooth, was cemented using the Panavia F 2.0 Estenia Cementing Kit (Kuraray, Tokyo, Japan) according to the manufacture's manual. In certain cases with undermined cusps, an onlay form of the composite resin restoration was provided. In cases with extensive coronal destruction, metal inlays fixed by resin cement were used. In most cases, the treatment was completed in one visit.

Post-treatment observations, including those using post-operative radiographs, were made to assess the changes of the clinical symptoms. In addition, any pain or discomfort on biting or chewing on the treated tooth was noted. Postoperative evaluation was done after the certain intervals (as longest, up to 14 years) indicated elsewhere.

The evaluation of outcomes was done whenever the patients visited and finally when they visited most lately after the

treatment.

The three clinical outcomes were defined as follows. A "good" clinical outcome was defined as the lack of any spontaneous pain, no mechanical allodynia to biting and the periapical radiolucent lesion was disappeared or reduced in size. Some cases were "under observation", because the size of radiolucent lesion was not changed, although no clinical symptoms and no mechanical allodynia to biting were observed. Thus, these cases were clinically good, and no further treatment was needed. An outcome of "failure" was defined by the deterioration of clinical symptoms, such as abscess formation, increased size of periapical radiolucent lesions, which needed the second LSTR 3Mix-MP endodontic treatment with the same procedure. The size of lesion was measured on X-ray photos, and the care was taken to use the X-ray photos showing the same width of tooth root to compare the change of lesion sizes.

## **Results**

### **Clinical aspects before retreatment**

A total of 161 teeth were involved in this study. All of them had been treated using conventional root canal preparation and root canal filling as their previous treatment elsewhere. All of them showed radiolucent periradicular lesions on X-ray photos (width: 1 ~ 15 mm) with other clinical symptoms, including swelling (61 cases). In 40 cases, swelling was limited within attached gingiva, and apical areas in 18 cases, and extended to facial areas in 3 cases. Sinus tracts were observed in 39 cases. A total 116 claimed pains from discomfort with slight pain (19 cases) to severe spontaneous pain (32 cases). Other claims included pain when the lesion areas were pressed (29 cases), percussion pain (7 cases) and pain on bite (48 cases).

The previous root canal filling had been obturated using lateral condensation technique in 43 cases, and using vertical condensation technique in 16 cases. Single-point technique, which used a main gutta-percha point with root canal sealer, had been used in 59 cases, and in 43 cases root canals had been obturated only with root canal sealer (Table 1-4). The X-Ray photos showed the obturation were given until just near the apex areas in 54 cases, and short not until apex areas in 107 cases.

It should be noted that fractured reamers were remained in 5 cases, and perforation to periodontium in 8 cases. Bifurcation lesions were observed in 8 cases and root fracture lines were found in 6 cases.

Some cases had been repeatedly treated for more than 1 year, and some teeth were notified as treatment-difficult and to be extracted.

### **Clinical outcomes of endodontic retreatment**

After the LSTR 3Mix-MP treatment, 46 cases (29 %) were evaluated the outcomes within a year, 71 cases (44 %) after between a year to 4 years, 26 cases after between 4 years to 7 years, 18 cases more than 7 years (Table 2).

In 108 cases among a total of 161 cases, periradicular lesions were disappeared on the postoperative X-ray photos. The mean of lesion size was 3.8 mm (range: 1 ~ 15 mm). The mean follow up period was 38 months (range: 3 ~ 144 months). The outcomes were evaluated as good.

In 42 cases, the sizes of radiolucent lesions were reduced. The radiolucent lesions of meanly 5.0 mm size (range: 1 ~ 15 mm) shrank to meanly 1.5 mm (range: 0.5 ~ 12 mm). The mean width of reduction was 3.4 mm (range: 0.5 ~ 12 mm). The mean follow up period was 26 months (range: 4 ~ 168 months). Thus, it was the tendency that the radiolucent lesions of larger sizes needed more time to disappear (Table 2). Because the

lesions in these cases had been reducing to disappear, the  
Table 1. Lesions and previous obturation

outcomes of these 42 cases were also evaluated as good.

No. of cases (size of lesions before treatment)				
Obturation on X-ray photos before treatment		Lesion on X-ray photos after treatment		
		Disappeared *	Reduced*	Not changed*
<b>Lateral condensation (total: 43 cases)</b>				
Length:	25	19	4	2
Just to apex	(mean size: 4.4 mm)	(mean size: 4.4 mm)	(mean size: 6.3 mm)	(mean size: 1.5 mm)
Length:	18	10	8	0
Short	(mean size: 3.7 mm)	(mean size: 3.1 mm)	(mean size: 4.4 mm)	
<b>Vertical condensation (total: 16 cases)</b>				
Length:	8	2	4	2
Just to apex	(mean size: 4.8mm)	(mean size: 3.5 mm)	(mean size: 6.5 mm)	(mean size: 2.5 mm)
Length: Short	8	4	4	0
	(mean size: 4.4 mm)	(mean size: 4.8 mm)	(mean size: 4.0 mm)	
<b>A single point + root canal sealer (total: 59 cases)</b>				
Length:	18	13	3	2
Just to apex	(mean size: 3.7 mm)	(mean size: 3.3 mm)	(mean size: 5.0 mm)	(mean size: 4.0 mm)
Length: Short	41	25	12	4
	(mean size: 3.9 mm)	(mean size: 4.0 mm)	(mean size: 4.3 mm)	(mean size: 2.0 mm)
<b>Root canal sealer only (total: 43 cases)</b>				
Length:	2	2	0	0
Just to apex	(mean size: 4.5 mm)	(mean size: 4.5 mm)		
Length: Short	41	31	8	2
	(mean size: 3.7 mm)	(mean size: 3.6 mm)	(mean size: 4.4 mm)	(mean size: 2.5 mm)

\* Outcomes of the LSTR 3Mix-MP endodontic retreatment. Lesion size was measured before treatment.

In 8 cases, the size of lesions (mean: 2.6 mm) did not seem to reduce on the postoperative X-ray photos and those cases were evaluated as "under observation" because there were no other clinical symptoms and the patients could bite on the tooth, respectively, without any discomforts (Table 2).

While, 3 cases got worse and were evaluated as "failed cases", because the sizes of radiolucent lesions seemed to expand, although no other clinical symptoms/disorders were observed (Table 2). It might be ascribed by the breakdown of margin areas and the formation of micro-leakages allowing the bacterial re-invasion. So, these cases were retreated using the same procedures with special cares for tight restoration. After the re-treatment, the cases were under observation

without any discomforts.

In this study, 3Mix-MP was placed on the previous root canal obturation. So, the previous root canal filling materials were not removed, and clinical outcomes did not depend on previous root canal obturation methods, because 96%, 88%, 92 % and 95% cases done by lateral condensation, vertical condensation, single point, and root canal sealer, respectively, were evaluated as good clinical outcome (Table 1). In the same manner, the previous root canal obturation conditions did not affect the clinical outcomes in this study. Thus, clinical outcomes were good in 87 % and 96% of cases of which root canal obturation had been so called 'just' in length and short in length, respectively (table 1).

Table 2. Clinical outcomes

	Change of radiolucent lesions			
	Disappeared	Reduced	Not changed	Worse
No. of cases	108 cases	42 cases	8 cases	3 cases
Mean size (Range)	3.8 mm (1 ~ 15 mm)	5.0 mm (1 ~15 mm)	2.6 mm (1 ~ 5 mm)	3.7 mm (3 ~ 5 mm)
Mean reduction	3.8 mm	3.4 mm	0 mm	-2 mm
Mean months of follow-up (Range)	38 months (3 ~ 144)	26 months (4 ~ 168)	46 months (3 ~144)	* (* )

\* Under observation after re-restoration

## Discussion

It was clearly demonstrated that excellent clinical outcomes were obtained for the retreatment cases that had failed in

conventional endodontic treatment. In the present retrospective clinical study, we applied only 3Mix-MP medication locally without removal of previous obturation for the retreatment. This might mean that 3Mix-MP penetrated previous root canal obturation *in vivo* and disinfect lesions, which had been demonstrated in our *in vitro* and *in situ* study (23, 28). The present study also clearly demonstrated that, after disinfected, periradicular radiolucent lesions disappeared or reduced, thus the lesions repaired. We call this treatment system as "Lesion Sterilization and Tissue Repair (LSTR)" and do the clinical way to leave root canal system untouched as "Non-instrumentation Endodontic Treatment (NIET)". Thus, the present study demonstrated that LSTR 3mix-MP NIET therapy is excellent for endodontic retreatment.

The might be quite useful and convenient for dentists, who are feeling conventional endodontic treatment is somewhat complicated and needs matured clinical techniques, because LSTR 3mix-MP NIET therapy is quite simple and easy, and yet brings excellent clinical outcomes which should be one of the important factors for public dental treatment. Conventionally, when root canals need retreatment after the previous treatment, the previous root canal obturation has to be removed, and repeat the same endodontic procedures including root canal preparation and root canal obturation, but it may not be sure for the dentists whether the retreatment is good enough if the previous endodontic treatment had been done with the same manner and failed.

The molecular sizes of 3Mix components are quite small and, thus, it is quite understandable that 3Mix-MP penetrated endodontic obturation (23, 28), but the size of bacteria is much more bigger, so, if root canal obturation is tight, bacteria, if any was in dentinal tubules of root canal walls, may be packed and not immigrate to cause periradicular lesions. However, it is also the fact that recurrent symptoms happen often after the previous endodontic treatment. Conventional root canal obturation may not always perfect to seal up bacteria within endodontic root canal system to prevent the immigration to periradicular tissue. The shapes of root canals are complicated with fin and isthmuses structures. It has been clearly demonstrated that root canal obturation, even it seems to be tight on two-dimensional X-ray photos, many defects are found on three dimensional Micro-CT images (28). In addition, minute air-bubbles formation and/or boundary problems between root canal wall dentin and obturation materials may also cause defects in the obturation and allow bacteria immigrate.

It can be considered that the most important factor to cause recurrent symptoms after previous endodontic treatment should be bacteria remaining and surviving in lesions (2). Bacteria that invade newly through the loose sealing may also cause recurrent symptoms. If so, LSTR 3Mix-MP NIET therapy, aiming first to eliminate causative bacteria (24), is quite reasonable. Tight restoration, using glass-ionomer cement as the first sealing and direct-method-resin-inlay cemented by resin cement as the second tight sealing, may keep lesion sterile and induce new dentin and/or cementum formation finally to seal lesions. Softened dentin is recalcified to strengthen the tooth structure and, at the same time, the dentinal tubules fill up with newly formed calcified crystals.

This new paradigm has been applied not only for endodontic retreatment, but also general dental practices including dental caries (24), pulpitis (26) and root canal treatment (25) without removal of so called "infected dentin" including softened dentin, pulp tissue, and root canal instrumentation and root canal obturation, and clinical outcomes have been excellent (24~26), indicating that fundamental principles in these cases is elimination of causative bacteria from lesions ("Lesion Sterilization"). Most cases have been done by one-visit

treatment. Under sterile conditions, damaged lesion tissue is easy repaired, which happens generally and commonly as the final process of human infective inflammation. Of course, this paradigm will not exclude conventional endodontic treatment, and it is also clearly shown that when conventional endodontic treatment is done properly, the clinical outcome is also good. Because LSTR 3Mix-MP therapy is time-saving, simple and easy but still excellent (24~26), and do not need expensive dental machines/equipment and dental materials, this new paradigm using 3Mix-MP may most likely suit for public dental practices or even for general dental practices if the endodontic patients are abundant.

### Conclusion:

Relapse of radiolucent lesions was successfully retreated using 3Mix-MP without removing previous obturation.

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