

Seven-year Follow-up of Resin Infiltration Treatment on Noncavitated Proximal Caries

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Clinical Relevance

Clinicians should consider resin infiltration as a good treatment option of noncavitated proximal caries carefully.

SUMMARY

The purpose of this case report is to present success and failure outcomes of seven-year follow-up of resin infiltration treatment (RIT) used for the proximal caries of maxillary premolars. Although resin infiltration can be a good option for micro-invasive treatment, long-term follow-up data are not sufficient,

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and the outcome of this technique can be affected by factors such as technique sensitivity of procedure, patient's caries risk, and depth of caries progression. Therefore, careful case selection, application, and follow-up are needed.

INTRODUCTION

Dental caries is a disease of tooth structures and may result in cavity formation. Conventional invasive treatment for proximal caries is to remove caries lesion and fill the cavity with restorative materials.¹ Cavitated lesions should be restored through invasive treatment because they cannot be cleaned effectively by patients.² The caries removal and restoration put the patient in the restorative cycle. This is because, considering the limited longevity of restorations, they may need to be replaced and result in larger restorations.^{2,3} Therefore, in the case of noncavitated lesions, alternative approaches such as noninvasive treatment and micro-invasive treatment for proximal caries lesions were developed. Noninvasive treatment is managing rather than removing caries lesions and includes things such as biofilm control, antibacterial treatment, and remineralization. Micro-invasive treatment is conditioning the tooth surface before the treatment of the caries lesion. There are two kinds of micro-invasive treatment: sealing and resin infiltration. Sealing is



Figure 1. Preoperative radiograph and clinical photograph. On radiograph, proximal caries were found between the maxillary right first and second premolars (between #4 and #5).

performed to prevent dental caries in the pits and fissures on occlusal or pitted tooth surfaces. It creates an outer barrier to protect, from the outside, bacterial acid attack, and loss of mineral from within the tooth.¹ On the other hand, resin infiltration creates an internal barrier in the proximal and smooth surface caries lesion, so retention loss of this barrier is unlikely to occur, unlike sealing.^{1,4}

The concept of resin infiltration treatment (RIT) was introduced more than 40 years ago.^{5,6} To enhance the penetration of resin into the lesion, the method of using highly permeable resin was first introduced in the mid-2000s.⁷⁻⁹ A product called ICON (DMG, Hamburg, Germany) was released, which consists of low-viscosity resin—triethylene glycol dimethacrylate (TEGDMA). This is a more invasive method than noninvasive treatment such as fluoride treatment for the inhibition of early caries. In RIT, the demineralized surface is treated with hydrochloric acid to increase the micro-porosity,¹⁰ and then water is completely removed with alcohol

to enhance the penetration of the low-viscosity resin.¹¹ This is a new concept of treatment that inhibits the progression of caries by creating an internal barrier.^{1,4} Several people expressed concern about the efficacy of RIT because the acid conditioning for RIT can debilitate the residual strongest component of the teeth; they insisted that remineralization or restorations are more effective for caries management than RIT.¹² However, with careful case selection, procedure application, and close follow-up accompanying RIT, RIT can be a good treatment option as a micro-invasive treatment for caries lesions.

According to the indications claimed by the manufacturer, RIT can be used for proximal dentin caries up to the outer third of the dentin.¹³ Several studies have reported clinical success on these dentin caries up to the outer third. However, most reports of success were short-term results, observed within 3 years.¹⁴⁻¹⁷ Therefore, the purpose of this case report is to present success and failure outcomes of a long-term, seven-year follow-up of RIT used on the proximal caries of maxillary premolars.

CASE REPORT

A 35-year-old male patient came to the Department of Conservative Dentistry for a dental checkup. He had no discomfort, but on periapical radiographic and clinical examination, he had multiple caries. On the maxillary first and second premolars were proximal dental caries limited to the enamel layer (Figure 1).

On #4 and #5, prophylactic treatment, beyond just monitoring the lesions, was needed considering the patient's high caries risk. We excluded placing direct resin restorations, which would have resulted in more tooth loss than the caries area that was limited to the enamel layer. We elected to do resin infiltration on the caries. After application of an orthodontic elastic ring separator for two days to improve accessibility, we used ICON, following the manufacturer's instructions.

A rubber dam and wedge were applied, and ICON etch (15% hydrochloric acid) was applied for two minutes on the #4 and #5 proximal area. After water rinsing for 30 seconds and air drying, the water was removed thoroughly by ICON dry (99% ethanol). The resin infiltration was applied with a proximal nozzle for three minutes and light cured with Mini LED Satelec (1250 mW/cm²; Acteon Group, Merignac, France) for 40 seconds for each

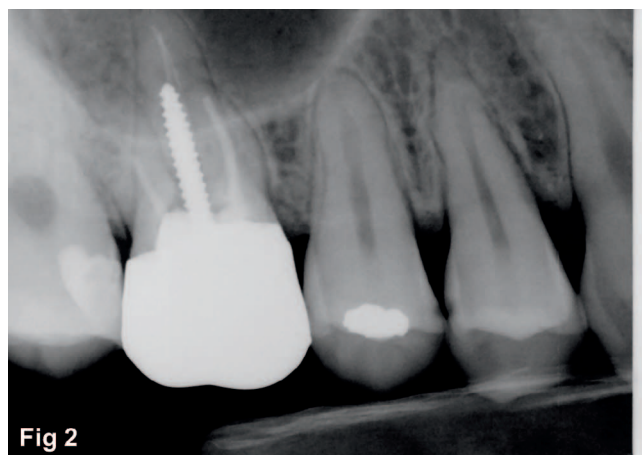


Fig 2

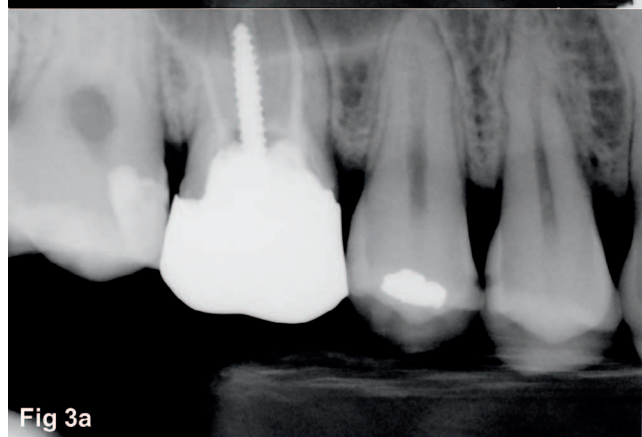


Fig 3a



Fig 3b

Figure 2. Postoperative radiograph after resin infiltration on #4 and #5 proximal area. There was no difference on the radiograph because infiltrated resin has no radiopaque filler.

Figure 3. (a) Eight-month follow-up on radiograph. (b) Eight-month follow-up on clinical photo. No change was found.

surface. Secondary resin infiltration was applied for one minute and light cured for 40 seconds (Figure 2).

The patient came back after eight months, and no change was observed on the bitewing radiograph or clinically (Figures 3a, 3b). After the visit, he did not return for more than five years; at six

years, he came to our clinic. He was in no discomfort, but the #5 distal proximal caries had progressed deeper into the dentin layer on radiographic and clinical examination (Figures 4a, 4b).

After the examination, we decided to perform a direct resin restoration on the #5 distal area. Under infiltration anesthesia, the caries was removed. When the enamel layer was removed, a widespread caries lesion in the dentin was observed, whereas the #4 mesial proximal caries had not progressed (Figure 5). It was discolored and dark, but the surface was intact, so we just polished the tooth with a silicone rubber point (Jiffy rubber, Ultradent Products Inc, South Jordan, UT, USA). On the #5 distal area, we performed a resin restoration with Tetric-N-Ceram (Ivoclar Vivadent, Schaan, Liechtenstein) after applying 37% phosphoric acid etching for 10 seconds, Clearfil SE bond (Kuraray, Kurashiki, Japan) application, and light curing with Mini LED Satelec for 10 seconds on bonding application. Tetric-N-Ceram was light cured for 40 seconds (Figure 6).

DISCUSSION

The principle of resin infiltration is penetration of low-viscosity resin (TEGDMA) into the subsurface pores to form hybrid enamel. This hybrid enamel stops demineralization, stabilizes the caries lesion, and acts as a superficial mechanical barrier to inhibit outer bacterial colonization and trap bacteria in the lesion.^{4,18}

Despite performing the same procedure on caries lesions close to each other (#4 mesial, #5 distal) simultaneously in the same patient's maxillary arch, outcomes of seven-year results were different (Figure 7). These different outcomes may have resulted from the degree of caries progression and resin infiltration. In this case, the #5 distal caries lesion had progressed more than the #4 mesial caries lesion, and it came close to the dentin-enamel junction (DEJ) (Figure 1). Dentin is more sensitive to caries than enamel, and furthermore, dentin is wet; this property restricts resin penetration into dentin because displacement of water is a prerequisite of resin infiltration.¹¹ Because the effect of caries inhibition depends on the penetration depth of resin, this effect would be restricted in deep caries lesions beyond the DEJ.

To overcome this limitation, Paris and others suggested that the resin penetration time should be longer than three minutes in caries lesions over

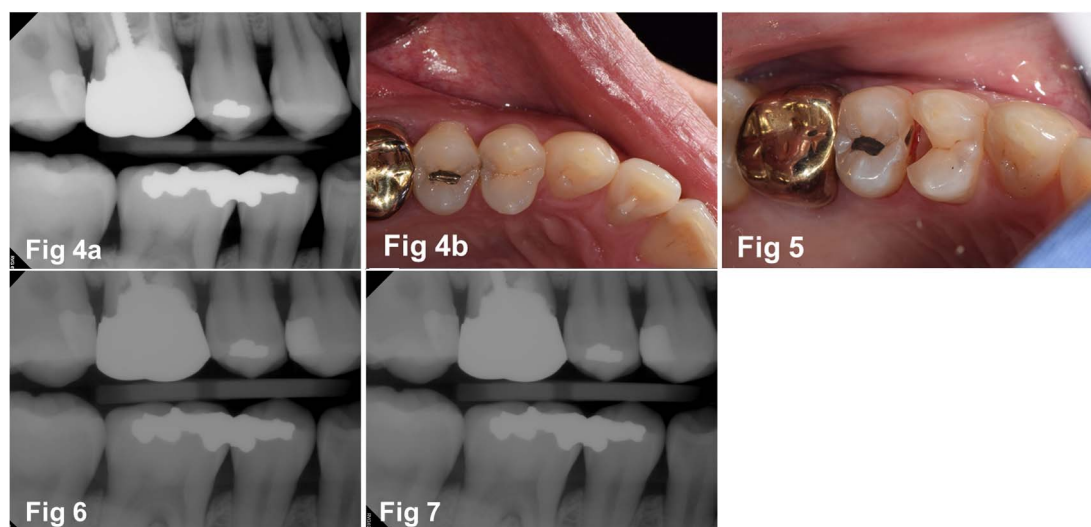


Figure 4. (a) Six-year follow-up on radiograph. (b) Six-year follow-up on clinical photo. #4 mesial proximal caries had not progressed, but the #5 distal proximal caries had progressed to the dentin area, and a distinct color change was observed.

Figure 5. The #5 distal caries was removed, and the #4 proximal surface was discolored but had intact surface, showing that #4 caries had not progressed.

Figure 6. Postoperative radiograph after resin filling on #5.

Figure 7. Seven-year follow-up. The #4 mesial proximal caries was maintained and had not progressed after seven-year follow-up.

400 μ m in the primary tooth.¹⁹ The manufacturer's guidelines recommend a three-minute resin infiltration time, and, following the results of this case report, this time might be considered insufficient in permanent teeth with a caries lesion near the DEJ. Because primary teeth are less mineralized and more porous in structure,²⁰ this makes for a higher diffusion coefficient and rapid infiltration. Therefore, a variation of the procedure such as increased resin infiltration time might be considered according to the depth of caries progression. To obtain more evidence-based results, a randomized clinical trial should be considered in the future.

If this patient had been followed up periodically, additional caries progression could have been detected earlier. Because he was not seen for 5 years, he missed the proper treatment time, and wider caries had to be removed. Therefore, the importance of periodic follow-up should be emphasized to patients.

When the clinician decides to use resin infiltration treatment, he or she should consider many factors, such as the state of the caries progression, risk of further caries, and patient compliance. It is difficult for the clinician to assess the surface zone formation in caries lesions to prevent caries progression. Therefore, decisions about caries lesion management and whether to follow-up or

turn to RIT or restoration should be carefully made. Also, periodic follow-up is essential for successful RIT.

SUMMARY

Although resin infiltration can be a good treatment option to inhibit the early progression of caries lesions as a micro-invasive treatment, long-term follow-up data have not accumulated yet. In addition, outcomes of resin infiltration can be affected by factors such as the depth of caries progression, treatment procedure, and compliance of patients. Therefore, careful case selection, application, and follow-up are necessary.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of Gangnam Severance Hospital, South Korea.

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Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature

or kind in any product, service, and/or company that is presented in this article.

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