ORIGINAL RESEARCH

Clinical and Radiographic Progression of Proximal Enamel Caries of Primary Molars Following the Application of Resin Infiltrant vs Tooth Mousse

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Abstract

Background: Resin infiltration is a technique in which a low-viscosity resin penetrates the proximal carious lesions and stops caries progression.

Aim: This study aimed to compare the progression of proximal enamel caries of primary molars following the application of resin infiltrant clinically and radiographically vs Tooth Mousse.

Materials and methods: This case–control split-mouth study evaluated 64 proximal surfaces of primary molars in 32 patients. Each patient had one pair of noncavitated proximal caries in two primary molars from different quadrants with radiographic evidence of enamel involvement. The carious lesions in each patient were randomly treated with resin infiltrant and Tooth Mousse. Progression of carious lesions was evaluated clinically and radiographically after 12 months. The two groups were compared by Fisher's exact test.

Results: No caries progression was noted in the resin infiltrant group at 12 months, and all 32 surfaces (100%) showed cessation of caries. Four surfaces (12.5%) in the Tooth Mousse group showed caries progression. The two groups were not significantly different in this regard ($p = 0.242$).

Conclusion: Resin infiltrant and Tooth Mousse were both effective in stopping the progression of proximal enamel caries of primary molars.

Keywords: Casein phosphopeptide–amorphous calcium phosphate nanocomplex, Deciduous teeth, Dental caries, Molars, Resin infiltration.

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Introduction

Dental caries is a common chronic disease, which is often detected by visual inspection and radiographic examination. However, caries detection by visual inspection is only possible for cavitated carious lesions, and noncavitated caries cannot often be detected by visual inspection alone. Detection of proximal caries is also difficult. Proximal carious lesions often have a slow rate of progression and cannot be detected radiographically until the incipient lesion involves over half of the enamel thickness. Also, around 40% demineralization should occur for the carious lesions to be detectable on conventional radiographs.[1,2]

Incipient proximal caries is a major oral health problem in children and adolescents.[3] Early detection and preventive treatment of these lesions are highly important since the progression of superficial carious lesions may be ceased through noninvasive interventions and oral hygiene adherence.[4] However, efficient cleaning of interproximal areas is much more difficult than the buccal and occlusal surfaces of the teeth. Thus, the rate of proximal caries is often high in adolescents and young adults.[5]

Noninvasive treatment of proximal caries may be able to stop the progression of caries.[6] In recent years, glass ionomer cements, composite resins, and bonding agents were used to seal the proximal areas and were shown to effectively stop the progression of proximal caries.[7–11] In addition to sealing proximal caries, infiltration of low-viscosity light-cure resin into the carious lesion has been suggested as an effective strategy to stop the progression of caries,[12] and several studies have reported promising results of this technique.[13–17] A previous study reported that 23% of resin-infiltrated primary molars (application of varnish + resin infiltrant at baseline and after 6 months) and 62% of control teeth (application of fluoride varnish at baseline and after 6 months) showed radiographic evidence of caries progression after 1 year in young children with moderate to high risk of caries.[17]

On the other hand, a previous study with a 3-year follow-up reported 32% progression of caries in the resin infiltration group vs 70% in the control group.[18] Another study reported a 7 and 37% rate of caries progression in resin infiltration and control groups, respectively, after 18 months.[17] In the resin infiltration technique, low-viscosity resin penetrates the porous structure of enamel caries,[19,20] blocking the leakage of cariogenic acids into the lesion. Thus, the carious lesion is internally sealed. This technique requires minimal tooth isolation. Thus, it has easy clinical application, particularly in the proximal areas.[12,21]

GC Tooth Mousse, containing casein phosphopeptide–amorphous calcium phosphate (CPP-ACP), is a remineralizing agent

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introduced to stop the progression of caries. It is commonly used for enamel and dentin remineralization, caries prevention, and treatment of tooth hypersensitivity.[22,23]

Considering the novelty of the technique, the importance of assessing previous studies about resin infiltrant for primary molar caries and the lack of studies comparing the efficacy of resin infiltrant and GC Tooth Mousse for this purpose, this study aimed to clinically and radiographically compare the progression of proximal enamel caries of primary molars following the application of resin infiltrant vs GC Tooth Mousse.

Materials and Methods

This study was conducted at the School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran. The study was approved by the ethics committee of this university (IR.TUMS.DENTISTRY.REC.1398.100).

Study Design

This split-mouth case–control study compared the efficacy of resin infiltrant (Icon Caries Infiltrant—Smooth Surface, DMG America Company—Hamburg, Germany) as case group and GC Tooth Mousse as control in carious primary molars.

Participants, Eligibility Criteria, and Settings

Patients presenting to the university clinic were clinically examined for carious lesions, and those suspected of proximal caries underwent digital bitewing radiography using a film holder and putty impression material.[24]

The inclusion criteria were age range of 5–10 years,[25] having a minimum of one pair of noncavitated proximal enamel caries in two primary molars from two different quadrants, being cooperative, having no systemic diseases, and parents consenting to the participation of their children in the study. The exclusion criteria were missing primary molars, allergy to milk protein, allergy to benzoate preservatives, and severe dental crowding. In total, 64 surfaces of primary molars were evaluated after obtaining written informed consent from the parents. In each patient, a minimum of two noncavitated proximal enamel caries in two primary molars were selected based on clinical (observation by using 3.5× magnification eyeglasses[26] and exploration by a dental explorer) and radiographic evidence (digital radiography after mounting the film holder using putty impression material). Radiographic assessment was performed only if the presence of caries was approved clinically and to ensure that the carious lesion was confined to the enamel.[27]

Interventions

For the control treatment group (Tooth Mousse; GC, United States), the parents were requested to apply the paste on the selected surfaces daily for 1 month, according to the given instructions. They were also asked to use dental floss for all proximal surfaces at least three times a week and regularly use fluoride toothpaste. Also, they all received oral hygiene and nutritional instructions.

In the case group (resin infiltration), the teeth were rinsed and dried. The enamel surface was then etched with 15% hydrochloric acid gel (ICON-Etch; Suring DMG, Hamburg, Germany) for 2 minutes. Next, the tooth was rinsed with water for 30 seconds and dried with gentle water- and oil-free air spray until the surface did not appear wet. The teeth were then dehydrated with 99% ethanol (ICON-Dry; Suring DMG, Hamburg, Germany) for 30 seconds and were dried again with gentle oil- and water-free air spray. Resin infiltrant (ICON-Infiltrant; Suring DMG, Hamburg, Germany), supplied in a syringe by the manufacturer, was then applied on the enamel surface for 3 minutes. Excess material was removed by a cotton roll, and light-curing was performed for 40 seconds. According to the manufacturer's instructions, resin infiltrant was applied again on the tooth surface, and after 1 minute, excess material was removed by a cotton roll, and light-curing was performed for another 40 seconds.

The patients had been visited after 12 months and underwent bitewing digital radiography again. All bitewing radiographs were obtained by Digora Optime digital radiographic system (Soredex; Helsinki, Finland) with size 1 photostimulable phosphor plate sensors measuring 24 × 40 mm, and also a Minray Periapical X-ray Unit (Soredex; Helsinki, Finland) with the exposure settings of 70 kVp and 0.16 mAs using a Kerr film holder (KaVo Kerr Family, Switzerland). For standardization of radiographs, custom-made holders were designed for each patient. For this purpose, the patient's bite on the holder was recorded by using a putty index during the primary radiography. By using the same holder for the second radiography after 12 months, the second radiograph was obtained with the same angulation as the first radiograph by the parallel technique. The clinical evidence of caries progression/cessation was also examined after 12 months. Examinations were performed by the same clinician by visual inspection and exploration by a dental explorer to find out whether a carious lesion had become cavitated. The patients were also asked about any complications following treatment. The progression of carious lesions was recorded by comparing the primary and secondary digital radiographs of patients, and those with D2 and D3 lesions were referred for restorative treatments.

Sample Size Calculation

The sample size was calculated to be 64 tooth surfaces according to previous studies.[28,29]

Interim Analyses and Stopping Guidelines

No interim analyses were performed, and no stopping guidelines were established.

Randomization

For the purpose of randomization, the carious surfaces were coded, and the codes were written on a piece of paper. The papers were placed in sealed envelopes, and the children were requested to select half of the envelopes. The selected surfaces by the child were treated by resin infiltration while the remaining surfaces were treated with GC Tooth Mousse.[16]

Blinding

The observer who performed radiographic examination after 12 months was blinded to the group allocation of tooth surfaces.

Statistical Analysis

The progression of proximal carious lesions was compared between the two groups using Fisher's exact test *via* Statistical Package for the Social Sciences (SPSS) version 25 at a 0.05 level of significance.

Results

Participant Flow

A total of 64 proximal surfaces of primary molars (32 patients) were evaluated.

Harms

No patients were harmed during the study.

Subgroup Analysis

In clinical assessment, none of the surfaces had become cavitated; thus, no case of clinical progression of carious lesions was noted in any of the two groups.

In radiographic assessment, no case of progression of carious lesions was noted in the resin infiltration group, and all 32 surfaces treated with this method (100%) showed cessation of caries at 12 months. However, in the Tooth Mousse group, four surfaces (12.5%) showed progression of caries while 28 surfaces (87.5%) showed no caries progression. A 12-month radiographic follow-up of a patient is shown in Figure 1.

According to Fisher's exact test, the difference in caries progression was not significant between the two groups at 12 months ($p = 0.242$) (Table 1).

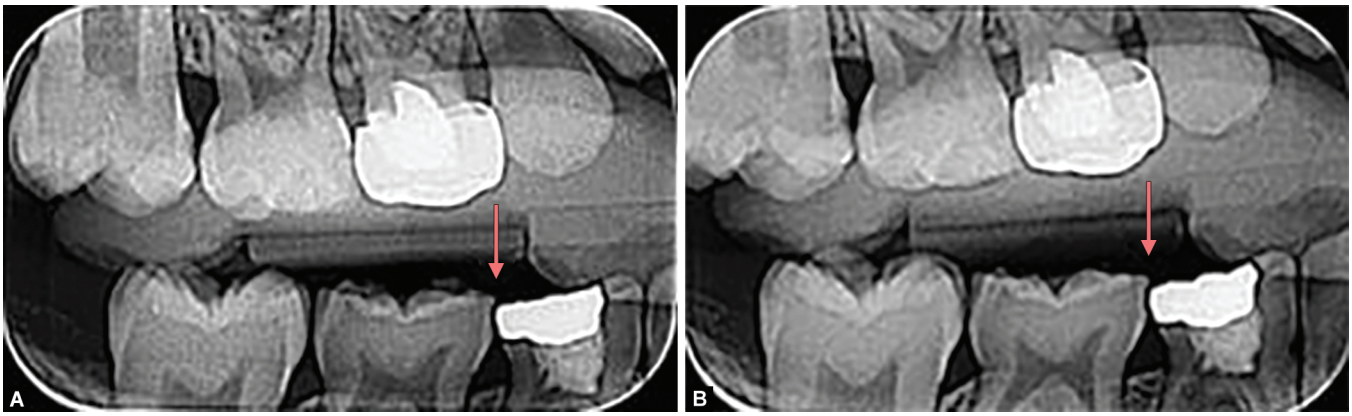
Upon asking the parents, no complication was reported for any of the two treatment methods.

Discussion

The prevalence of proximal caries is on the rise in both primary and permanent dentition.[20] Resin infiltration of carious lesions is a relatively novel technique to prevent the progression of incipient noncavitated proximal carious lesions.[30] The evidence on this technique currently is quite rare, and any definite conclusions cannot be reached; however, considering available studies, it seems that resin infiltration can diminish (or even cease) the development of enamel lesions.[12] Thus, this study clinically and radiographically compared the progression of proximal enamel caries of primary molars following the application of resin infiltrant vs GC Tooth Mousse. The results showed no significant difference in caries progression between the two groups and no evidence of caries progression in any of the teeth in the resin infiltration group at 12 months was clinically noted.

Jorge et al.[31] evaluated the progression of noncavitated proximal caries in primary molars 2 years after resin infiltration + dental flossing, and dental flossing alone, and reported that the rate of caries progression was 24.1% in the experimental and 55.2% in the control group. The caries progression rate was 0% in the resin infiltration group in the present study. The difference in the results of the two studies may be due to differences in the duration of follow-up (12 months in our study vs 2 years in their study) and sample size. Arthur et al.[32] reported that the progression of proximal caries after 3 years of follow-up was 7.4% in resin infiltration and 18.5% in the control group, with no significant difference between them. The lack of a significant difference between the two groups in their study was similar to our findings; however, the rate of caries progression was 0% in the resin infiltration group in our study, probably due to the shorter follow-up period. Foster Page et al.[33] reported that the rate of proximal caries progression after 24 months was 22.7% in the resin infiltration + fluoride varnish group vs 43.5% in the fluoride varnish monotherapy group. In their study, the 2-year therapeutic effect of resin infiltration compared with fluoride varnish was 20.8% which was higher than the 12.5% reported in the present study; this difference may be attributed to longer follow-up in their study or the use of Tooth Mousse in the control group in the present study. The rate of proximal caries progression in a study by Meyer-Lueckel et al.[34] was 5 and 31% in resin infiltration and control groups after 18 months, respectively. The same group of authors in another study reported the rate of progression of the same carious lesions to be 4 and 42% after 3 years in resin infiltration and control groups, respectively.[13]

Paris et al.[16] reported that the rate of caries progression after 18 months was 7% in resin infiltration and 37% in the oral hygiene control group. The rate of incipient proximal enamel caries progression after 24 months was 40% in resin infiltration



Figs 1A and B: Application of resin infiltration on mesial surface of second primary molar (A) After 6 months follow-up; (B) After 12 months follow-up

Table 1: The frequency of proximal caries progression in primary molars of children in resin infiltration method and Tooth Mousse application in 6-month follow-up

	Caries progression		
Method	*Stopping the progression*	*Progression*	*Total*
Resin infiltration	16 (100.0%)	0 (0%)	16 (100.0%)
Tooth Mousse	14 (87.5%)	2 (12.5%)	16 (100.0%)
Total	30 (93.8%)	2 (6.3%)	32 (100.0%)

+ topical 5% NaF group and 72% in the control group (topical 5% NaF alone) in a study by Bagher et al.[24] Their results were in agreement with our findings; however, higher rate of caries progression in resin infiltration group in their study compared with ours may be attributed to their longer duration of follow-up. Ammari et al.[25] reported the rate of progression of noncavitated proximal caries in primary molars to be 11.9% in resin infiltration + fluoride toothpaste + dental floss group vs 33.3% in fluoride toothpaste + dental floss group after 1 year. In the present study, all patients were instructed to use fluoride toothpaste and dental floss. The difference between their results and ours may be due to the use of Tooth Mousse in the control group in the present study. Tooth Mousse has CPP-ACP in its composition, which reacts with calcium and phosphate and prevents enamel demineralization and caries as such.[23,35] CPP-ACP binds to biofilm, plaque, bacteria, hydroxyapatite, and soft tissue in the oral environment, and localizes the biologically available calcium and phosphate. Saliva also increases the efficacy of CPP-ACP, and the taste of CPP-ACP stimulates the saliva flow.

Resin infiltration aims to stop the active process of caries by creating a resin layer within the lesion, serving as a barrier against caries progression. This is particularly useful for proximal caries since dental plaque cannot be easily removed from the proximal areas.[36] Some differences exist in the progression of carious lesions following resin infiltration. For instance, in the study by Ekstrand et al.,[17] the rate of caries progression was twice the value reported by Foster Page et al.[33] Also, the rate of progression of proximal caries following resin infiltration in most previous studies was higher than that in the present study.[24,33] One explanation for such differences may be the variable susceptibility of different individuals to caries. Another reason may be the variations in the extent of carious lesions at baseline in different studies. For example, in the study by Ekstrand et al.,[17] carious lesions had extended to dentin in two-thirds of the cases at baseline while in the present study, the lesions were confined to the enamel and were noncavitated. Despite the greater progression of dentin caries,[37] infiltration of resin is greater in lesions confined to the enamel.[13,33] Also, some dentin caries may have small cavities not detectable by radiography, which can also enhance caries progression, and limit the efficacy of resin infiltration.[38] The use of a resin containing microfiller particles may overcome this limitation and increase the indications of resin infiltration to small cavitated proximal caries as well.[39,40] However, this statement needs further investigation.

Inadequate resin penetration into the carious lesions can be related to mineralized superficial areas.[41,42] Primary carious lesions have a faster progression than permanent carious lesions, resulting in their lower mineralization and the presence of thinner superficial layers.[43] In the present study, carious lesions involving the outer third of dentin were not evaluated because Tooth Mousse has a low penetration depth.[31,44]

The use of bitewing radiography and designing a custom-made film holder were among the strengths of this study since variations in the film position and angulation have been reported as limitations of previous investigations.[34] Also, both teeth treated with Tooth Mousse and resin infiltration were selected from the same individuals to eliminate the effect of confounding factors such as nutritional regimen and oral hygiene status on caries progression, which was another strength of this study. Moreover, by adopting a random strategy, the effects of variables such as type of tooth, tooth surface, and radiographic depth of caries were controlled for at baseline. The selection of all patients from one dental center was a limitation of this study, which may limit the generalization of results to the entire population.

Although the present results as well as those of many previous investigations have confirmed the superiority of resin infiltration compared with other methods, studies regarding the cost-effectiveness of this treatment are still required.

Conclusion

Resin infiltrant and Tooth Mousse were both effective to stop the progression of noncavitated proximal enamel caries of primary molars. No case of caries progression was noted in the resin infiltrant group, which is clinically important.

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