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RESIN INFILTRATION OF NON-CAVITATED CARIES LESIONS: REVIEW

Natasha Longurova

Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia

natasa.denkova@ugd.edu.mk

Katerina Zlatanovska

Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia

katerina.zlatanovska@ugd.edu.mk

Abstract: Dental carious lesions, which extend to the outer third of the dentin, have traditionally been treated with invasive procedures, preparation and filling. Non-invasive alternative methods (e.g. fluoride varnishes, flossing) can prevent further tooth demineralization and substance loss, with their effectiveness depending on the patient's cooperation and motivation. In recent years microinvasive methods for treating uncavitated carious lesions have been tried. These methods place a barrier on the surface of the lesion with the penetration of material into the body of the lesion (infiltration). Currently, several microinvasive methods of treatment of such lesions are available, and one is infiltration of the carious lesion with low-viscosity composite resins. The aim of this paper is to evaluate the effects of carious lesion infiltration, advantages and disadvantages of this method, and effect in the adult population. The review includes relevant literature from online databases (PubMed, Cochrane Library, MedLine), on the topic of resin infiltration of initial carious lesions as a method of non-invasive restorative treatment. The Resin infiltration technique presents an innovative approach that addresses both the prevention and treatment of carious lesions, specifically those extending up to the outermost layer of dentin (D-1). Additionally, it offers a solution for aesthetically displeasing white lesions on the outer surface of teeth, particularly on the cheek side. Marketed as Icon®, this technology by DMG America Company in Englewood, NJ, operates as a minimally invasive method. It works by filling, strengthening, and securing demineralized enamel, all while preserving the integrity of the surrounding healthy tooth structure. Prevention in itself brings many benefits, ensures the patient good oral health, brings great savings of time and money, reduces the stress that patients feel during conventional methods of preparation and restoration, and therefore it is very important that, when there is an indication in patients in the adult population for caries infiltration with resin, and recommend, and if the patient agrees with it, and carry it out.

Keywords: dental caries, resin infiltration, uncavitated lesions

1. INTRODUCTION

In recent times, there has been a significant shift in the approach to managing dental caries, moving away from traditional restorative treatments toward a more preventive strategy, specifically emphasizing non-invasive or minimally invasive methods. Enamel carious lesions are characterized by a loss of minerals within the lesion itself, resulting in increased opacity of the enamel visually, caused by changes in the refractive index of the affected area. There has been considerable focus on non-invasive treatments for enamel caries, such as the remineralization of lesions using fluoride and casein phosphopeptide-amorphous calcium phosphate, as well as the application of therapeutic sealants for occlusal lesions. Fluoride and casein phosphopeptide-amorphous calcium phosphate play crucial roles in the remineralization process, particularly in addressing superficial white spot lesions.

The rate of proximal caries increases between adolescence and early adulthood. In many countries, a high prevalence of proximal caries on first molars has been observed. Proximal caries progresses relatively slowly in permanent teeth and takes about 4 to 6 years to spread into the dentin. Therefore, there have been major changes in the philosophy of treatment, especially the threshold for the start of operative treatment.

Before any invasive treatment, caries can be stopped by non-invasive methods. However, methods such as improving oral hygiene, flossing, and fluoridation depend on patient compliance, so success may be questionable. Given that filling fissures has proven to be a successful method in controlling occlusal caries, the idea of creating a composite barrier between the biofilm and the initial proximal lesion is being studied more and more. Many studies show that infiltration of proximal lesions effectively reduced the progress of lesion development. Resin infiltration of initial carious lesions can be completed in one visit. Infiltration, which involves occlusion of the micropores of the carious lesion with low-viscosity resins, has shown clear therapeutic effects in younger adults by reducing the development of non-cavitated proximal carious lesions.

2. AIM

The purpose of this research is a critical review of the literature related to the clinical application, effectiveness and limitations of resin infiltration of initial carious lesions.

3. MATERIAL AND METHODS

The review includes relevant literature from online databases (PubMed, Chochrane Library, MedLine), on the topic of resin infiltration of initial carious lesions as a method of non-invasive restorative treatment.

The literature included different combinations of keywords: "caries infiltration", "resin infiltration", "icon infiltration", "white spot infiltration", "lesion infiltration" and similar.

4. RESULT AND DISCUSSION

- Demineralization and caries

Dental caries stands as one of the most prevalent ailments globally and notably the most common affliction affecting the oral cavity. Its onset is spurred by the metabolic actions of oral biofilm, spurred on by frequent consumption of fermentable carbohydrates, such as sugar. Caries manifests as the depletion of minerals within the hard dental tissues. Typically, in younger individuals, caries initiates within the enamel of the tooth. During the early and middle stages, affected enamel exhibits heightened porosity, visually presenting as a white chalky spot due to increased light scattering between the crystals and pores. Subsequently, in advanced stages, porous enamel deteriorates, leading to the formation of characteristic cavities.

Initially devised to halt non-cavitated caries lesions, caries infiltration presents an innovative solution. One notable effect of resin infiltration is the elimination of the whitish hue associated with damaged enamel during and post-infiltration. This occurs as the infiltrated resin diminishes light scattering between the enamel crystals. Consequently, lesions are concealed, offering a relatively simple means of achieving aesthetic enhancement with minimal loss of tooth structure.

- Processes within dental plaque

An essential component of dental plaque is the protein matrix. The protein matrix enables the formation of a young, immature environment in the early stages of dental plaque formation, and is characterized by high porosity, so that saliva or gingival sulcus secretion flows between the microorganisms, washing away the microorganisms. Oxygen creates aerobic conditions because it has access.

The plaque matures, and the microspaces between the microorganisms narrow considerably, and the dental plaque acquires a gelatinous appearance, and because of this, the diffusion of soluble components or plaque fluid becomes difficult or completely impossible. As a result, there will be an increased accumulation of acidic metabolites.

A drop in pH, which is a consequence of the action of lactic acid produced by the bacteria, causes this change in fluid saturation status, while an increase in calcium in the plaque fluid opposes the change in pH.3

If the pH value does not return to neutral for a long period of time, there will be a significant loss of mineral content from the enamel, and the appearance of a "white spot" as an initial carious lesion.

As a result of numerous experimental studies, it has been shown that the process of forming the initial caries lesion is directly dependent on the degree of saturation of the buffer acid solution with calcium and phosphorus salts. The lower the saturation of these salts in the solution, the faster the formation of the initial caries lesion on the enamel.

- "White Spot"

Microscopically, the mineral dissolution surface after 14 days is clearer and there is a tendency to lose minerals from the deeper enamel layers. By drying the teeth, a "white spot" lesion is clinically visible at this stage. After 4 weeks, the changes have a characteristic chalky or matte appearance and can be seen without drying the tooth surface. Mineral loss in the "white spot" stage cannot be detected either by radiography or with a dental probe, given that the enamel is hard and there are no visible cavitations. Pressure must not be applied when probing the "white spot", in order to avoid artificial cavitation. The fact that under the relatively well-mineralized surface of the enamel is the body of the carious lesion, where mineral loss ranges from 30-50%, is a reason to be careful when probing. This lesion can also acquire a brown color due to the absorption of exogenous substances.

The very fact that the "white spot" can be inactivated shows that efforts should be directed towards early diagnosis and prevention of further demineralization.

- Dental fluorosis

Dental fluorosis denotes a condition affecting the hard dental tissues, marked by increased porosity, particularly in the subsurface layer of enamel. This condition arises from prolonged ingestion of excessive fluoride during the process of enamel formation.

While fluorides play a crucial role in preventing dental caries, prolonged and excessive exposure to fluoride during enamel development can lead to fluorosis. The severity of fluorosis is directly correlated with the quantity of fluoride ingested during enamel formation. Mild dental fluorosis clinically presents as a diffuse whitish opaque alteration, caused by porous or hypomineralized subsurface enamel with an intact surface layer.

In recent times, resin infiltration has emerged as a viable option for aesthetically treating lesions categorized as mild to moderate fluorosis. In cases of milder fluorosis, the shallower subsurface pores are typically effectively

infiltrated, resulting in satisfactory aesthetic outcomes. However, in instances of moderate or severe fluorosis, preliminary mechanical removal of the affected enamel surface may be necessary before resin infiltration can be applied.

Diagnosis of caries on proximal surfaces

Early diagnosis of carious lesions on the proximal surfaces is difficult, given the fact that caries develops cervically and below the contact point, and there is limited visibility due to adjacent teeth. When this type of lesion is clearly detected clinically, it is already at a late stage and the lesion is already deep in the dentin. Retrocoronary X-rays are of the greatest importance in diagnosing approximal caries in both enamel and dentin. A proximal probe is recommended in such cases, but it must also be used gently and without pressure. Dental floss can also be used for diagnostic purposes. The thread is passed through the contact site into the interdental space, moved vestibulo-orally, resting on the suspected proximal surface, and returned towards the occlusal. If there is caries, the uneven edges of the carious lesion will rub off the floss.

Despite the existence of many classifications of carious lesions in the literature, the classification that includes the type of lesion and the degree of progression of carious lesions is the most commonly used:

- D0 - the initial lesion that often "hides" under dental plaque deposits and cannot be diagnosed by conventional methods. Macroscopically, it is an intact surface on the enamel, and microscopically, there are expanded hydroxyapatite crystals in the enamel.
- DI.1 - a smooth lesion in the enamel (white spot) that is observed after the removal of dental plaque. It can be diagnosed with more sensitive diagnostic tools. Macroscopically, it is observed only on a dry surface, and microscopically, the porosity of the enamel can be seen.
- DI.2 - the lesion is seen in the form of a whitish discoloration of the enamel, and due to the penetration of the pigment into the pores of the enamel, it can be darker in color. Enamel becomes porous and causes dentin demineralization (sclerotic dentin).
- D2- solid substance is lost at the enamel-dentine border. Macroscopically, microcavities caused by chewing, poor oral hygiene and inadequate (aggressive) use of the probe during diagnosis can be observed. Dentin sclerosis occurs under the lesion and intratubularly. The remineralization process is not efficient and acidophilic bacteria contribute to cavity deepening. The process can be stopped by preventive measures (odontoplasty and microinvasive procedures).
- D3 - the lesion affects the dentin and the hard tooth substance is completely infected with bacteria. There are also parts of the dentin where there are few bacteria and that vital part of the dentin transmits stimuli to the pulp. Bacterial products and acids destroy the dentine structure. If the course of caries is fast, sclerotic dentin does not form inside the tubules.
- D4 - the lesion spreads to the pulp and the pulp is usually exposed.

Indications and contraindications for resin infiltration of initial carious lesions

Indications

Microinvasive treatment of non-cavitated carious lesions (lesion depth up to grade D1 according to the classification based on "bite-wing" imaging)

Contraindications

The manufacturer advises that the material is not used in deeper lesions (D2-D3), nor on cavitated tooth surfaces.

The dentist must be familiar with the ingredients of the material and be aware that the material contains resins that can cause allergic reactions, and not use the material in case of allergy to any ingredient or in the presence of any allergic reaction in the patient.

Advantages:

- Aesthetic effect on smooth surfaces
- "Catches" caries in the initial stage
- Preserves healthy dental structures
- Microinvasive procedure, without anesthesia and preparation
- One short patient visit, and a quick and pleasant application

Disadvantages:

- Sometimes it is necessary to repeat the radiography due to insufficient contrast in case of initial caries
- Impossible to diagnose initial caries by dental examination without auxiliary diagnostic tools
- Iatrogenic cavitation in demineralized but intact enamel for diagnostic purposes
- Iatrogenic preparation of the infiltrated lesion that is monitored (drop-out)

Resin Infiltration Concept

The Resin infiltration technique presents an innovative approach that addresses both the prevention and treatment of carious lesions, specifically those extending up to the outermost layer of dentin (D-1). Additionally, it offers a

solution for aesthetically displeasing white lesions on the outer surface of teeth, particularly on the cheek side. Marketed as Icon®, this technology by DMG America Company in Englewood, NJ, operates as a minimally invasive method. It works by filling, strengthening, and securing demineralized enamel, all while preserving the integrity of the surrounding healthy tooth structure.

The principle of resin infiltration is to perfuse the porous enamel with resin by capillary action, thereby arresting lesion progression by occluding the microporosities that provide diffusion pathways for the acids and dissolved materials. This technique aims to create a diffusion barrier inside the lesion and not on the lesion surface.

Resin infiltration therapy is a more widely accepted ideal treatment approach to deal with white spot lesions on the teeth, including early caries lesions interproximally. Whilst the process is still invasive, utilisation of 15% HCl acid to etch the tooth surface and erode the superficial enamel, this technique can be considered the least invasive after bleaching alone. The reason for its minimally invasive nature, is based on the index of refraction. As this case demonstrates the white spot is still present underneath, however by placing a TEGDMA resin, we are able to mimic the refractive index of enamel, thereby masking the white spot lesion. TEGDMA resin is used due to its optimal penetration coefficient capabilities. Paris and colleagues (2010) have trialled and tested several combinations of etchant and resin combinations, with 15% HCl and TEGDMA coming out on top. More traditional methods require the removal of the white spot, whereas [ICON resin infiltration](#) simply needs access to the surface of the lesion, and then modification to the way the light interacts with the white spot by infiltration with a resin.

The Aesthetic Result of Resin Infiltration Treatment

In the dental field, there is a growing emphasis on cosmetics and aesthetics. With an increasing number of patients seeking minimally invasive cosmetic improvements that don't require anesthesia or drilling, resin infiltration emerges as a viable option. This technique offers a micro-invasive approach to treating white spot lesions on smooth surfaces, enabling the restoration of a natural tooth appearance.

5. CONCLUSION

Infiltration of initial carious lesions with low-viscosity resin is an excellent non-invasive restorative and "preventive" method, which in the future all medical professionals must promote and bring closer to adult patients, considering that they prevent more serious dental diseases, and therefore other diseases of the body. Prevention in itself brings many benefits, ensures the patient good oral health, brings great savings of time and money, reduces the stress that patients feel during conventional methods of preparation and restoration, and therefore it is very important that, when there is an indication in patients in the adult population for caries infiltration with resin, and recommend, and if the patient agrees with it, and carry it out.

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