Review Article

Resin infiltrants - A review

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Abstract

Tooth decay is a microbial, infectious and multi-factorial disease and is still globally a highly prevalent pathology. The management of Dental caries has dramatically changed in recent years, evolving from the traditional restorative treatment approach to a preventive approach, non-invasion or minimal invasion. Minimal intervention focuses on preventive or non-surgical methods to preserve dental hard tissues is a part of modern dentistry, this avoids any unwanted sacrifice of tooth structure, and also enhances the life of the tooth. Noninvasive management of non-cavitated caries lesions includes use of fluoride, casein phosphopeptide-amorphous calcium phosphate or therapeutic sealants for occlusal lesions. Resin infiltration is a much more tissue conserving approach to arrest and control the initial carious lesions. This concept aims at occluding the highly porous structures of incipient enamel lesion by means of low-viscosity resins. The potential caries-inhibiting effect of resin infiltrate acts by occlusion of the pores within the body of the lesion in contrast to the sealing of caries lesions that depend upon the external occlusion of the lesion with the sealant material. This ultraconservative approach effectively builds a covalently bound three-dimensional polymer framework thus partially replacing the lost minerals, encapsulating the hydroxyapatite crystals, micromechanically interlocking the remaining enamel prisms, and acting as an effective barrier for hydrogen ions to inhibit further demineralization and to arrest subsurface lesion progress. The aim of this review was to assess the scientific basis, principles and clinical applications of resin infiltrates.

Key words

Tooth decay, Dental caries, Resin infiltrants, Demineralization, Enamel caries.

Introduction

Dental decay is a microbial, infectious and multi-factorial disease and still remains a highly prevalent pathology globally [1]. Dental caries management has dramatically changed in recent years, evolving from the traditional restorative treatment approach to a preventive approach, non-invasion or minimal invasion. Minimal intervention focuses on preventive ornon-surgical management to preserve dental hard tissues is a part of modern dentistry, thus avoiding unwanted sacrifice of tooth structure, and also enhances the life of the tooth. Non-invasive management of non-cavitated caries lesions includes use of fluoride, casein phosphopeptide-amorphous calcium phosphate or therapeutic sealants for occlusal lesions.

Resin infiltration is a much more tissue conserving approach to arrest and control the initial carious lesions. This concept aims at occluding the highly porous structures of incipient enamel lesion by means of low-viscosity resins. The potential caries-inhibiting effect of resin infiltrate acts by occlusion of the pores within the body of the lesion in contrast to the sealing of caries lesions that depends upon the external occlusion of the lesion with the sealant material. This ultraconservative approach effectively builds a covalently bound three-dimensional polymer framework thus partially replacing the lost minerals, encapsulating the hydroxyapatite crystals, micromechanically interlocking the remaining enamel prisms, and acting as an effective barrier for hydrogen ions to inhibit further demineralization and to arrest subsurface lesion progress [2, 3].

The aim of this review was to assess the scientific basis, principles and clinical applications of resin infiltrates.

Resin Infiltration Concept

Resin infiltration technique is a novel technology that bridges the gap between prevention and restoration of carious lesions. Resin infiltrate Icon was introduced in Germany in 2009. Manufacturers claim that this is an innovative product for the micro-invasive treatment of early carious lesions in the proximal and vestibular regions. It can be used to treat caries in a timely manner without drilling.

It is marketed under the trade name Icon®(DMG America Company, Englewood, NJ) in two different forms: proximal surface and vestibular surface kits. Resin infiltration works on the principle of perfusion of the porous enamel with resin by capillary action and thus it helps in arresting progression of lesion by occluding the microporosities which may act as 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 [4] Robinson, et al. reported that about 60± 10% of the lesion's pore volume had been occupied by resin [5]. According to Kielbassa, et al. resin infiltrates into subsurface lesions and produces resin infiltrated parts of the lesion and the depth of resin infiltration was over 100µ [6].

Basic principle of ICON use:

Icon composition and function

ICON is basically unfilled resin which penetrates porous structure of enamel by property of capillary action. It is available as two variations, proximal and smooth. Proximal is developed for proximal carious lesions and Smooth surface is especially developed for infiltration for post orthodontic decalcified lesions which are non cavitated. ICON kit comes with three main components- etchant, ICON dry and unfilled resin.

The composition of ICON etching gel is Hydrochloric acid, photogenic silicic acid, and surface active substances. ICON dry has 99% ethanol. ICON infiltrant has methacrylate based resin matrix, initiators, and additives [7].

Resin Infiltration Technique

ICON material is technique sensitive, the working and setting times of ICON RI is acceptable. ICON needs a completely dry field and the material can fail if it comes in contact

with any moisture on the tooth surface. The tooth surface is dried using dry, moisture free air, further procedures should be performed to dry the surface by treating the lesion area with ethanol. During its use, the ICON material must be dispensed carefully as the packaging of the ICON material, involves a syringe from which the substance is dispensed. As the syringe plunger is depressed, the quantity of material that is dole out is much greater than necessary and the excess material must be wiped away with a cotton swab [7].

(i)Preparation phase:

As the enamel surface is less porous, first the surface of the tooth is cleaned and prepared with 15% hydrochloric acid (icon etch) for 2 minutes and stirring the gel from time to time during application with a microbrush. 15% hydrochloric acid gel has been demonstrated to be superior to 37% phosphoric acid gel in removing the mineralized surface layer of natural teeth [8].

(ii)Ethanol wet bonding technique:

It is used to desiccate the surface by applying 99% ethanol (Icon Dry) for 30 seconds followed by air drying to assuming that it will coax hydrophobic monomers to infiltrate into demineralized wet enamel or dentine, and improve the efficacy of penetration of the hydrophobic infiltrate to get a well-defined, resin-infiltrated layer.

(iii)Icon Resin Application:

Icon resin, composed of TEGDMA, is applied on the surface of the lesion using a microbrush and allowed to penetrate for three minutes. After removing excess using a cotton ball the material is light cured. This procedure is repeated by applying the material for another one minute and then the resin is light cured again. Two applications are preferred one after the other, because single application can result in spaces which can be occluded by the second application. The excess resin is then removed and the surface is polished [8, 9].

Resin Infiltration in Primary Teeth

In primary teeth the enamel is less mineralized, more porous and a prismatic when compared to permanent enamel. So, primary enamel has a greater diffusion co-efficient than permanent. Also, the proximal surface layer is less mineralized and thinner in primary molars compared to the permanent molars and thus, the rate of progression of proximal caries in primary molarsis significantly higher than that in the permanent teeth [10]. Therefore the management of non-cavitated caries lesions using the resin infiltration technique in primary teeth differs from that in permanent teeth.

Principle Concept of Mechanism of action of Resin Icon infiltrant:

Resin Icon infiltrant has the properties such as low viscosity, low contact angle, high surface tension and high penetration coefficient with RI of 1.47. The resultant RI is 1.52, which is close to that of healthy enamel. This makes the difference in refractive indices between porosities and enamel to be negligible and lesions appear similar to the surrounding sound enamel. Since it has a chameleon effect no shade matching is required. Lesions blend reasonably well with surrounding natural tooth structure and loose their white opacity [11]. Hence, an immediate improvement in the esthetic appearance is observed. In order to overcome the interference of resin by the mineralized surface the surface of the lesion is conditioned with 15% hydrochloric acid gel prior to its application.

Clinical Applications

1. White spot lesions (WSLs)

Increased porosity within the enamel carious lesion characterized by mineral loss beneath an apparently intact surface layer causes characteristic whitish appearance. Thus, these lesions are often called white spot lesions (WSLs). This can be explained by the principle of refractive index. Refractive index (RI) of sound enamel is 1.62, whereas that of porous enamel is 1.33 when it is filled with watery medium and 1.0 when filled by air. This significant difference in refractive indices, causes

changes in the scattering of light leads to the formation of white spot lesion [12].

Cosmetics and esthetics are current trends of dental industry. Due to awareness and knowledge acquired by the patients, there is more and more demand for minimally invasive cosmetic enhancement without anesthesia and drilling/ cavity preparation, the technique of resin infiltration may be considered as one that allows for the recovery of natural tooth appearance. The porosity created by the initial demineralization of a caries process changes the refractive index of enamel, resulting in a white discoloration in the incipient lesion. An additional positive effect on esthetics of the resin infiltration technique is its penetration and polymerization of the low viscous resin inside the body of the lesion allowing a change of the lesion's whitish appearance to the natural enamel appearance [13 14, 15, 16].

After thorough cleaning of the affected tooth and adjacent teeth, the rubber dam is applied. ICON etch is used to dispense ample amount of etch on the lesion and let to sit for 2 min. This process is repeated twice if the white surface lesion is not treated immediately after bracket removal. The area is then rinsed to wash away the ICON etchant for at least 30 sec. followed by drying with water free and oil free air. After applying ICON -Dry the whitish opaque appearance should disappear. If it does not disappear theetching step should be repeated once more. Etching is advised twice - thrice depending on how recent the white spot appearance was. After rinsing apply ICON dry-sit for 30 sec. On the dried surface the resin is applied with a new smooth surface tip. Apply an ample amount on etched surface and let sit for 3 min. Remove excess material with a cotton and light cure for 40sec. The rubber dam is then removed and the tooth surface is polished with polishing cups for smooth finish [17].

2.Incipient proximal caries

Resin infiltrants can also be used for treating incipient proximal caries [18].

3. Post orthodontic enamel scars

Resin infiltrants have been tried in treating post orthodontic enamel scars.

4. Developmental defects of enamel (DDE)

Development of ameloblasts is highly affected by even minor changes in their surrounding environment. The resulting enamel defects vary depending on the nature and severity of the insult as well as the stage of tooth development. It is believed that the whitish opaque appearance of DDE may be caused by subsurface porosities in the enamel below a well-mineralized surface layer. It has been demonstrated that hypomineralized enamel is resistant to conventional acid etching [19]. This, in turn, may contribute to poor micro-tag formation at the interface between hyopmineralized enamel and adhesives leading to bonding failure and microleakage [20, 21]. It was noticed that lesions infiltrated by resin took on the appearance of the surrounding enamel. Opaqueness of enamel lesions can be reduced by filling the microporosities with resin and they will look similar to the sound enamel. The masking effect of resin infiltration on DDE was studied by Kim, et al. [10] who showed that the masking effect was dramatic in some cases, but not in others and that only 60% of teeth with DDE were completely masked. However, aesthetic improvement was still observed in teeth with incomplete penetration. Schnab, et al. [20] showed that resin infiltrant can penetrate a defect up to 2 mm. However the cases should be selected carefully.

Teeth with brown discoloration may not be good candidates for resin infiltration, since the later will not mask the brown color and, in fact, it may saturate the color and make it look worse clinically. Microabrasion or conventional resin restorations may be better options for treating teeth with brown discoloration.

Advantages [6, 22]:

1. Good patient acceptance
2. Single visit treatment
3. Preserves tooth structure and noninvasive

4. No postoperative sensitivity and pulpitis
5. Lesion progression arrested/retarded
6. Low risk of gingivitis and periodontitis
7. High esthetic result
8. Low risk of secondary caries
9. More penetration into demineralized areas
10. Resin infiltration application on proximal incipient caries lesions increased the surface roughness and hardness significantly [23].
11. Resin infiltration treatment (Icon®), provided effective results as a micro-invasive treatment of anterior teeth with hypomineralized lesions [23].
12. the other advantages of the ICON technique include mechanical stability of demineralized enamel, maintenance of hard solids, permanent closure of surface micropores, clogging of porous in deeply demineralized areas, inhibiting lesion progression by increasing resistance to demineralization and respecting patients' desire for aesthetics [17].

Limitations of Resin Infiltration

Even though the resin infiltration technique has opened up a new range of options for minimal invasive treatment of white spots, some factors may affect the success of the treatment [22]. ICON works on the principle of infiltration and requires a very dry field. Apart from keeping the environment moisture-free, additional steps must be taken to dry the lesion. This is accomplished by treating the lesion area with alcohol, which evaporates the water within the porosities, which can inhibit the process of infiltration.

1. Inefficient isolation;
2. Incomplete resin polymerization;
3. Depth of the lesion - Contraindicated in deeper lesions up to D2, D3 or cavitated enamel. It is Advisable to use 'ICON etch' only on enamel surface and not on exposed dentin or on cementum surface. Or it can cause pin and discomfort to the patient.
4. Extensive lesions are also associated with a higher polymerization shrinkage and the consequent appearance of porosities and cracks. The infiltration of cavitated lesions does not produce satisfactory results, taking into account the weak capillary action of the resin into these lesion [23].
5. The greater the depth of the carious lesion, the lower will be the probability of achieving a complete infiltration
6. Other Contraindications are allergy or intolerance to material components [12].

Conclusion

The ICON (Infiltration concept) is a technique which can be used as a form of a minimally invasive procedure for the treatment of early caries in patients of all ages. The advantage of this procedure includes minimum damage to the tooth structure due to the low viscosity of the restoration.

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