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Revisiting Resin Infiltration- An Overview

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Abstract

Resin infiltration technique is a minimally invasive technique to treat white spot lesions which brings about a good esthetic improvement. It is an innovative procedure which meets the concepts of minimally invasive dentistry while allowing obtaining satisfying aesthetic results without grinding away any tooth structure. They are widely used in treatment of white spot treatment lesions of teeth which may be of carious or non-carious origin. It is composed of a polymerisable resin matrix which gets polymerised on exposure to visible light and it is devoid of fillers. As a result this low viscosity light cured resin literally penetrates into the porosities of lesions and results in a camouflaged effect and also arrest the penetration of cariogenic bacteria. It results in strengthening of enamel structures. We can conclude that an unfilled resin have high penetration efficiency into lesion porosities and also further stops the progression. Resin infiltration is capable of masking the esthetic problem effectively while strengthening the enamel structure Thus resin infiltration technique is a promising minimally invasive approach to treat incipient carious lesions. In spite of these advantages this technique has few drawbacks including colour change or staining, reduced surface hardness, increased water sorption, physical properties deterioration on constant exposure to oral fluids. With proper patient compliance and good follow up

procedures the longevity of resin infiltration can be improved. Thus in this review article the history, mechanism of action, components and advantages were elucidated while highlighting the drawbacks.

Keywords: Resin infiltration, carious and non-carious lesions, white spot lesions, micro hardness, demineralisation, surface roughness, staining potential.

Introduction

Minimally invasive methods are the new era of modern dentistry, it integrates the concepts of prevention, remineralisation, minimal tooth preparation, arresting lesion progression to preserve possible tooth structure with the help of new innovative approaches. Resin infiltration is an innovative procedure which meets the concept of minimally invasive restorative dentistry and also allows to obtain satisfying aesthetic results without grinding away any tooth structure. They are used to treat white spot lesions of carious and non-carious origin. Caries initially begin as surface demineralisation which appears as white spots. With available diagnostic aids, caries can be diagnosed early and managed by minimally invasive treatment approaches, which includes microabrasion which involves grinding away of tooth structure using microabrasive paste containing silicon carbide microparticles and 6.6% HCl; remineralisation which includes fluoride, varnish, sealant application in which superficial layers are treated leaving behind the porosities in body of the lesion which creates a diffusion pathway for acids and bacteria and doesn't camouflage the white spots completely. Resin infiltration technique is based on the fact that low intensity, hydrophilic, light cured resin literally penetrates into porosities of non cavitated lesions, inhibiting the diffusion pathway to cariogenic bacteria, changing chalky appearance to almost normal form by altering the refractive index without sacrificing healthy tooth structure [1].

Thus resin infiltration is advantageous than the above mentioned procedures as it doesn't involve grinding of superficial surface of enamel, penetrates and seals upto subsurface porosities. Resin infiltration is a single appointment procedure and has high success rate when compared to other procedures [1].

Resin infiltration has opened up an innovative pathway in the treatment of carious lesions corresponding with goals of dentist to treat lesions with minimal intervention. This article reviews the scientific evidence available on resin infiltration treatment, its applications, properties, advantages and drawbacks.

History of Resin Infiltration

The prime idea of resin infiltration was first put forward by Buonocore, then the ability of resin to penetrate into porous enamel lesions was described over 30 years ago by Davila et al 1975 and Robinson et al in 1976 [2]. Robinson came up with resorcinolformaldehyde based material for incipient caries infiltration but the suitability of resin as caries prophylactic became questionable [3]. Since then the effectiveness of using dental adhesives and fissure sealants has been investigated. Then Paris et al ended up with conclusion that sealants and adhesives doesn't have high penetration and hence showed superficial penetration of lesions. After several investigations in 2008 Paris et al came up with special resins optimized for rapid capillary penetration, the so called resin infiltrants patented by ICON Germany [4].

Type of Enamel Discolouration

The whitish discolouration of teeth may be of carious or non-carious origin. Non carious causes resulting in demineralisation of enamel or dysmineralsiation of enamel as coined by Croll and white spot appearance due to non-carious origin in tooth include mild dental fluorosis, turners hypoplasia, molar incisor hypoplasia. White spots also appear in carious lesions, one such

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example is white spot lesions occurring in patients undergoing fixed orthodontic treatment where maintenance of oral hygiene becomes difficult leading to plaque accumulation and decalcification of enamel adjacent to the fixed appliances. Enamel carious lesion are characterised by demineralisation leading to difference in refractive index between sound enamel.

Components and Its Significance

The composition and the directions for use of the components are given in Table 1.

Table 1: description of the components present in resin infiltration procedure with clinical instructions for use.

Clinical Steps	Agent Used	Instructions For Use
1. Etching	15% HCl	▪ Apply required amount of gel and leave it for 2 minutes ▪ Remove excess material with cotton roll ▪ Rinse with water for 30 seconds followed by drying with oil and water free air.
2. Dehydration	Ethanol	▪ Apply required amount of gel and let it set for 30 seconds ▪ Dry with oil and water free air
3. Resin infiltration	TEGDMA based resin	▪ Apply required amount of infiltrant and let it set for 3 minutes ▪ Remove excess material and light cure the infiltrant for 40 seconds ▪ Repeat the step once or twice until the white spots are completely masked.

A. STEP 1- ETCHING: Etching is done to remove the surface hypermineralised layer and to ensure and facilitate good flow of resin into subsurface porosities. Buoncore in 1955 reported that penetration of enamel surfaces which is etched increases the adhesion of resin to enamel [9]. For resin infiltration 15% HCl is used for about 120 seconds followed by rinsing it with water. In ultramicroscopic studies it was revealed that use of HCl caused preferential dissolution of prism cores along with dissolution of inter prismatic substance [10] and a more higher magnification reveals presence of funnel holes in core of prism and depth of enamel etched varies between 0.9 to 2.0µ.

B. STEP 2- DEHYDRATION: In this ethanol is used for dehydration or drying, here 99% ethanol is applied over etched tooth surface and allowed to sit for 30 seconds followed by clearing the excess with a blast of water and oil free air [11]. This is based on 'ethanol wet bonding' technique, as ethanol is a hydrophilic water soluble compound, it can be used to draw out water from porosities present in enamel as it does in case of dentinal tubules. This steps ensures to increase the enamel-resin bond strength. The ethanol wet technique results in deeper penetration of resin into interprismatic areas and better resin tag formation [12].

C. STEP 3- RESIN INFILTRATION: In resin TEGDMA, Triethylene Glycol Dimethacrylate, is preferred as it has low viscosity which is due to weak polar bond interaction between two chains of TEGDMA and flexible backbone structure. Other reasons for low viscosity include presence of linear chain between two functional methacrylate groups of TEGDMA. The currently used resin infiltration systems are mostly light cure type. Among the initiators present the most preferred one is type 2 photoinitiator- camphoroquinone. The concentration of photoinitiator present influences various properties of resin like degree of conversion, mechanical properties, chemical instability but not surface hardness. Increase in concentration of photoinitiator can increase the degree of conversion and improve the mechanical properties but it might lead to a colour shift towards yellow [13]. This system is available in two forms namely ICON Caries infiltrant proximal and smooth surface.

After completing the above mentioned steps apply the resin, allow it to sit for 3 minutes and then light cure for 40 seconds. Depending on the intensity of white spots the resin can be applied over in layers until desired outcome is achieved [11].

Advantages of Resin Infiltration

Micro invasive procedure, preserving tooth structure. Have better penetration into lesions than adhesives.

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1. No post-operative complications like sensitivity, pulp inflammation, gingival inflammation.
2. Masking of white spots, thus resulting in improved aesthetic results
3. TEGDMA based resins have good flexural strength, high elastic index so they are less capable of plastic deformation.
4. Strengthening of demineralised enamel structure and also prevents further lesion progression
5. Bleaching the tooth surface prior to resin infiltration imparts a better masking effect.

Drawbacks

Despite having various benefits, the resin infiltration technique has drawbacks attributed to its components or patient compliance factors. In most of the cases the effectiveness of resin infiltration was reduced due to its degradation and dissolution of infiltrant to oral fluids.

A HIGH RATE OF WATER SORPTION- High rate of water sorption is attributed to the presence of TEGDMA in resin, as it has long and linear monomer spacer which separates the functional and polymerisable group. The main property of spacer is its hydrophilicity which causes water sorption this in-turn results in hydrolysis of monomers and staining of resin [14] when exposed to various extrinsic colouring agents like beverages, food colour, mouth rinses.

Hydrolysis bond between the monomer in resin affects the properties drastically and results in decreased tensile, flexural strength, modulus of elasticity and wear resistance [15].

B. Reduced Surface Hardness: Hardness of the resin is affected by the presence of poorly polymerised resin layer formation as a result of oxygen inhibition of polymerisation reaction , as a result of oxygen inhibition poorly polymerised or totally inhibited resin surface layer forms. The mechanism behind this is the inhibition of the setting mechanism caused by reaction of oxygen with free radicals involved in light cured polymerisation. This also affects the elastic modulus of resin [16, 18].

Thermocyclic changes makes the resin more vulnerable to microcracks which in-turn reduces the surface hardness of resin [17].

Hydrolytic breakdown of resin components and plasticisation of resin matrix caused by water sorption will also reduce the surface hardness in due course of time [14].

C. STAINING OF RESIN INFILTRANT- Hydrolysis of resin as a result of water sorption increases the chances for staining when exposed to various colouring agents like beverages, food colour, mouth rinses [14].

Increased surface roughness because of microcracks caused by thermocyclic changes makes it more prone to staining [17].

D. PLAQUE BIOFILM ACCUMULATION- increased surface roughness and the release of aromatic unreacted monomers from the resin on reaction with oral fluids favours plaque and biofilm accumulation [18] this further increases chances of demineralisation.

E. LOWERED RESIN LUMINOSITY- The amount of camphoroquinone used greatly affects the properties of resin, camphoroquinone is usually intense yellow which adds a yellow tint to uncured resin and this usually bleaches out after polymerisation. Presence of excessive camphoroquinone or incomplete polymerisation of resin can impart yellowish colouration to resin and also lowers the resin luminosity. This affects the aesthetic outcome of treatment but also has other benefits like increased degree of conversion and improved mechanical properties of the resin [19, 13].

F. COLOUR CHANGE: After exposure to acids, it was found that resin infiltrated groups showed mild colour change from initial, the reason may be due to partial acid

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resistance offered by resin. When resin is introduced into lesions it replaces the air and saliva present in porosities and surrounds enamel prisms, there may be some defect in this due to insufficiency of resin or due to shrinkage during curing. This uncoated enamel prisms undergo demineralisation and cause leakage in seal provided by infiltration, this leads to mild colour change [13].

G. CARIES RECURRENCE: The durability of infiltration is dependent on the lesions environment and patient compliance. There are high chances of caries recurrence at the periphery of the resin infiltrated areas if there is presence of strong demineralising environment.

Proper diagnosis by the clinician and differentiation between cavitated and non cavitated lesions plays a major role in the success of resin infiltration treatment [4].Thus it is concluded that infiltrant showed a higher extent of oxygen inhibition, lower hardness, elastic modulus and higher plastic to elastic indentation energy. These inferior properties may reduce sealing capacity, durability, and mechanical strength of intraorally exposed part of infiltrant coating [18].

Conclusion

Progression of dental caries and other white spot lesions is initiates when the equilibrium between demineralisation and remineralisation is hampered. With presence of numerous methods to the practitioner, sound knowledge about the material with simultaneous application of technical skills enables us to achieve an outstanding aesthetic and functional result. With the limitations of this study, we can conclude that unfilled resins have high penetration efficiency into lesion porosities and also further stops the progression. Thus resin infiltration technique is a promising minimally invasive approach to treat incipient carious lesions. In spite of these advantages this technique has few drawbacks including colour change or staining, reduced surface hardness, increased water sorption, physical properties deterioration on constant exposure to oral fluids. With proper patient compliance and good follow up procedures the longevity of resin infiltration can be improved. Further longterm studies on properties of resin infiltration and modifications to overcome the drawbacks are needed.

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