Review Article

Caries Prevention – Newer Horizons: A Review

Katiyar A, Kohli A, Singh G, Gupta K, Gupta S, Srivastava S

Abstract: Prevention is a philosophy of practice based on a perspective that focuses on maintaining health rather than on treating a disease. Modern methodology for the prevention of progressive oral diseases includes the identification of patients at high risk of developing diseases. The purpose of modern dentistry is the early prevention of tooth decay rather than invasive restorative therapy. However, despite tremendous efforts in promoting oral hygiene and fluoridation, the prevention and biomimetic treatment of early caries lesions are still challenges for dental research and public health, particularly for individuals with a high risk for developing caries, which is the most widespread oral disease. Recent studies indicate that nanotechnology might provide novel strategies in preventive dentistry, specifically in the control and management of bacterial biofilms or remineralization of submicrometre-sized tooth decay. This article details the various agents that enhances and promotes remineralisation.

Keywords: Antibacteria; Caries; ICON; Biofilma; Remineralization; Resin Infiltration Technique.

INTRODUCTION

The laser is a relatively The outcome of dental caries is determined by the dynamic balance between pathological factors that lead to demineralization and protective factors that lead to remineralization. Pathological factors include acidogenic bacteria, inhibition of salivary function, and frequency of ingestion of fermentable carbohydrates. Protective factors include salivary flow, numerous salivary components, antibacterials, fluoride from extrinsic sources, and selected dietary components. Minimal invasion dentistry is a key component in today's dental practice. Its first basic principle is remineralisation of early carious lesions, advocating a biological or therapeutic approach.

Remineralization takes places at a higher pH of 7.5 to 8.5 in the presence of calcium and phosphate in the water among the enamel or dentine crystals recrystalize on the surface of existing crystals remnants.[1] The calcium and phosphate come primarily from saliva and the mineral formed during remineralization is more resistant to acid than the original enamel or dentin mineral especially if fluoride is present to enhance remineralization and to be incorporated into the new crystals surfaces.[1] If complete remineralization of subsurface lesions is the goal, then the agent must also be able to diffuse past the pellicle- cov- ered enamel surface and into the subsurface lesion area. It has been found to be very difficult to diffuse calcium and phosphate ions into the deeper layers of carious enamel, and most remineralization is confined to the surface of a carious lesion.[2]

A new technology in dealing with such lesions is known as "Resin Infiltration". It seems to provide an intermediary treatment modality between prevention and restorative therapy. The concept was introduced as a micro-invasive approach for the management of smooth surface and proximal non-cavitated carious lesions. The purpose of this review is to present the scientific basis and principles of the usage of resin infiltration technique as well as its importance in the clinical practice.[3]

With the evolution of dentistry and the progress in preventive and adhesive technologies, new techniques are applied for preventing and stopping the carious process in the aim to preserve the tooth structure: so called "non invasive" and "minimal invasive dentistry". Minimal invasive dentistry is "a systematic respect for the original tissue" by removing and replacing with as little tissue loss as possible.[4] The Concept of minimally invasive techniques in dentistry requires a good diagnosis of risk and lesions, the use of the right preventive treatment to stop disease, the restorations of the lesions with as little healthy tissue loss as possible, the use of durable materials and the prevention of recurring disease.[5]

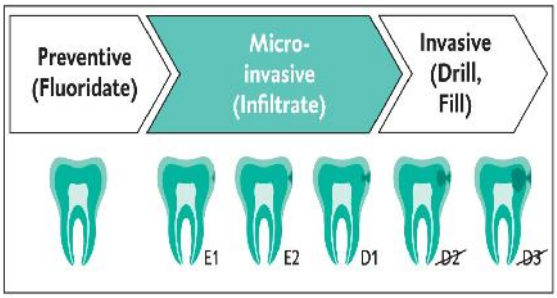
Clinically, the degree of remineralization seems to be limited, and this has been attributed to the presence of organic substances attached to the enamel surface

occluding the underlying pores in the carious lesions.[6] In addition, the depth of remineralization is limited resulting in a slow, but continuous progression of the lesion into deeper layers.[6] Sealing of interproximal initial lesions has also been suggested, but despite its ability to arrest some caries lesions, it still exhibited a high percentage of lesion progression.[7] In addition, the technique is difficult clinically. It only seals the superficial area of the lesion and the excess resin cannot be easily removed promoting the development of secondary caries and periodontal irritation.[8]
Once the lesions progress into the middle or inner third of dentine, they are cavitated and invasive restorative treatment is recommended. Uncertainty in treatment often exists for radiolucencies extending into the inner part of enamel or the outer third of dentine. In a clinical study, 8-11% and 22-44% of such lesions respectively were found to be cavitated.

Concept of Resin Infiltration: Resin infiltration technique is a novel technology that seems to bridge the gap between noninvasive and minimally invasive treatment of initial dental caries, postponing as long as possible the need for a restoration. The concept of caries infiltration was first developed at the Charité Berlin and the University of Kiel as a micro-invasive approach for the management of smooth surface and proximal non-cavitated caries lesions. It is marketed under the name Icon® (DMG America Company, Englewood, NJ).[9]

Principle: The principal of resin infiltration is to perfuse the porous enamel with resin by capillary action. This aims to arrest lesion progression by occluding the microporosities that provide diffusion pathways for the acids and dissolved materials. It has been debated that bacteria entrapped at the base of lesions could trigger and spread the caries process. It has been well established that the count of bacteria in non-cavitated lesions is low and not detrimental especially if properly sealed.[10]

When to use ICON
Smooth and interproximal surface lesions in the past have been treated with techniques from micro-abrasion to traditional bur removal, to a variety of chemotherapeutic regimens that allow re-mineralization and halt demineralization. The ICON systems use a special “high –penetration” resin, which is drawn into a lesion by way of capillary action, ultimately penetrating and filling the sub-surface pore system of an incipient caries lesion. Once inside the lesion, the resin sets up a diffusion barrier , limiting further demineralization and changing the lesion’s whitish appearance.
Only true demineralized smooth surface lesions, typically seen in post-ortho cases, are candidates for caries infiltration. Those that present from enamel defect, fluorosis , or trauma are not suitable for treatment as they lack the sub-surface pore system necessary for infiltration. Lesions that are present radiographically as E1 to D1 are suitable to be treated with ICON.[11]



Icon is applicable for early caries lesions with a radiographic depth up to the outer third of the dentine (D1)

Icon is an innovative product for the microinvasive treatment of dental lesions in the proximal region and on smooth surfaces.

Icon is available in two variations:

1. Icon Resin Infiltrant – Proximal is specially developed for proximal dental lesions.
2. Icon Resin Infiltrant – Smooth Surface is specially developed for the infiltration on smooth surfaces, it is particularly well- suited for orthodontic patients after bracket removal. Unless white spots are being treated shortly (1-2 months) after bracket removal, it is recommended that the etching process is performed two times. If a white spot is still visible after the Icon-Dry has been applied, then a third etching process is recommended.

Procedural Steps: The procedure is simple to follow and all materials and equipment are in cluded in the Icon kit. The steps include: isolation of the tooth, application of an etchant (Icon Etch), application of the drying agent (Icon Dry), 2 applications of the infiltrant resin (Icon Infiltrant), and light curing at each infiltrant step. Key to success of the technique is strict adherence to manufacturer's instructions. The amount of scientific literature behind each step of the technique is vast. For example, composition, timing, and frequency of repetition of the Icon Infiltrant step is cited in several studies, and the most effective practice is examined in detail. The same in-depth research has been executed for the Icon Etch, Icon Dry, and the light-curing steps.[12]

The results advocate the use of 15% hydrochloric acid gel for 2 minutes, followed by drying of the surface and application of a low viscosity resin of type TEGDMA (tri-ethylene glycol dimethacrylate).The procedure for resin infiltration is fairly simple and acceptable by operators and patients. This layer should be removed. Hydrochloric acid gel (15%) has been demonstrated to be superior to 37% phosphoric acid gel in removing the surface layer of natural enamel lesions when applied for 120 seconds.[13]

The surface is then dehydrated with 99% ethanol (ICON Dry) to facilitate the drying process. The philosophy of using ethanol wet bonding technique, in a clinically acceptable dehydration period, is based on the assumption that it will coax hydrophobic monomers to infiltrate into demineralized wet enamel or dentine, and improve the efficacy of penetration of the hydrophobic infiltrate (TEGDMA) to get a well-defined, resin-infiltrated layer.[14]

The technique involves slowly replacing water within the demineralized collagen matrix with ascending concentrations of ethanol, allowing the latter to penetrate the collagen matrix without causing additional shrinkage of the interfibrillar spaces thus preventing phase separation of hydrophobic resin monomers. The last step involves light curing of the resin following a three minute application time. A repeated application for another one minute is performed then the resin is light cured again. The excess resin is then removed and the surface is polished. Several studies on artificial caries-like lesions have demonstrated that commercially available adhesives having infiltrated the micropores of demineralized areas revealed a considerable reduction of lesion progression by either double application or extended penetration times. However, using resin infiltrants have proved superior penetration potential, depth and arresting caries progression capacity.[15]

Resin Infiltration in Primary Teeth:

The use of resin infiltration technique for the management of non-cavitated caries lesions in primary teeth is expected to differ from that in permanent teeth. Firstly, the progression rate of proximal caries lesions in primary molars is significantly higher than in permanent teeth. Secondly, the ultrastructure and mineral composition of primary enamel is different; as it is less mineralized and more porous and aprismatic in comparison with permanent enamel. As a result, the diffusion coefficient seems to be greater in primary enamel. Thirdly, the proximal surface layer is less mineralized and thinner in primary molars compared with permanent ones.[16]

Primary teeth exhibited better infiltrant penetration than permanent teeth even after shorter duration of application. In fact, after 1 minute of application of the resin on primary molars in vitro, the non-cavitated lesions were deeply and consistently infiltrated. In consequence, etching the surface of primary teeth with 15% hydrochloric acid for 120 seconds resulted in reliable and considerable erosion of the mineralized surface layer deeper than that seen in permanent teeth.[17]

In fact, after 1 minute of application of the resin on primary molars in vitro, the non-cavitated lesions were deeply and consistently infiltrated.On the other hand, 3-5 minutes are required to almost completely infiltrate a natural lesion in permanent teeth with an extension into the inner half of enamel. In fact, irrespective of the lesion depth, a minute application would result in

rather superficial infiltration only in permanent teeth.[17]

Clinical trials have shown that for non-cavitated proximal caries lesions being extended radiographically -at maximum- to the outer third of dentine, caries infiltration, in combination with non-operative procedures, were significantly more efficient in arresting lesion progression compared with non-operative measures alone in primary molars.[16]

Post-orthodontic demineralization:
In terms of esthetics, masking enamel lesions by resin infiltration is based on changes in light scattering within the lesions. Sound enamel has refractive index (RI) of 1.62. The microporosities of enamel carious lesions are filled with either a watery medium (RI 1.33) or air (RI 1.0) .[15]The difference in refractive indices between the enamel crystals and medium inside the porosities causes light scattering that results in a whitish opaque appearance of these lesions, especially when they are desiccated.[18] The novel technique used involves the infiltration of the carious lesions with resin (RI 1.52) that, in contrast to the watery medium, cannot evaporate and is similar to that of apatite crystals. This makes the difference in refractive indices between porosities and enamel to be negligible and lesions appear similar to the surrounding sound enamel. Lesions lose their whitish opaque color and blend reasonably well with surrounding natural tooth structure.[18] Resin infiltration technique was found to be an effective treatment for masking white spot lesions in vitro and in vivo.

It is believed that the masking effect depends on the lesion depth and activity. A recent in vitro study showed superior esthetic results of resin infiltration of artificial white spots when compared with remineralization after the application of fluoride. The surfaces treated with resin infiltration technique were found to have an increased surface micro hardness than smooth surface initial caries lesions, increased resistance to further demineralization and mineral loss, and increased resistance to brushing abrasion than normal enamel. In addition, adhesion to such surfaces was similar to that of sound and demineralized enamel and even enhanced in some cases.[19]

CONCLUSION: The early detection of caries and the assessment of individual caries risk would be of a lot of help in preserving the tooth structure and avoiding unnecessary trauma to the dental tissues. When indicated, minimal invasive dentistry such as resin infiltration technique seems to provide a good solution in dealing with early enamel lesions as recommended by many recent studies in this field. Such technique could also be used in combination with other enamel remineralizing agents like fluoride varnishes, fluoride gels, non-sugar containing chewing gums etc Patient's motivation would probably play a major role in the success of any minimal invasive dentistry technique. It is always possible to shift to more invasive restorative procedures in case of failure of resin infiltration in patients where white spot lesions continue to progress and start to cavitate. Further studies with longer periods of follow up are necessary to confirm the efficiency of this treatment modality and encourage the clinicians to use it in their dental practice. In the last few decades, advances in technologies, changes in lifestyle, modifications in the diet and longer life expec- tancy are some of the many factors which have affected the health and esthetics of tooth enamel and dentin. A goal of modern dentistry is the non-invasive manage- ment of non-cavitated caries lesions involving remin- alization systems to repair the enamel with fluorapatite or fluorhydroxyapatite. With a clearer understanding of the implementation of these remineralizing agents and new technologies accessible to dentists, we can create a more favorable relationship in which remineralization occurs more often than demineralization.

Author affiliation: 1.Dr. Ashish Katiyar, MDS, Reader, 2 Dr. Anil Kohli, MDS, Professor. & HOD, 3.Dr. Garima Singh, MDS, Reader, 4. Dr. Kirtija Gupta, MDS, Reader 5. Dr. Sukriti Gupta, PG Student, 6. Dr. Shipra Srivastava, PG Student, Dept. of Pedodontics & Preventive

Dentistry Rama Dental College, Hospital & Research Centre Kanpur, U.P, India.

REFERENCE

1. Nidhi G, Kunwarjeet S. Try to believe it-amazing Remineralizing technologies. J Pharm Biomed Sci. 2012 Nov;24 (24):79-82
2. Larsen MJ, Fejerskov O. Chemical and structural challenges in remineralization of dental enamel lesions. Scand J Dent Res 1989 Aug; 97(4):285-296
3. Azizi Z. Management of White Spot Lesions Using Resin Infiltration Technique: A Review. Open J Dent Oral Med 20153(1): 1-6.
4. Ericson D, Kidd E, McComb D, Mjör I, Noack MJ. Minimally Invasive Dentistry, concepts and techniques in cariology. Oral Health Prev Dent. 2003;1(1):59-72.
5. Xie-Qi Shi, Sofia Tranæus, Birgit Angmar-Maº nsson. Validation of DIAGNOdent for quantification of smooth-surface caries: an in vitro study. Acta Odontol Scand. 2001:59(2):74-78.
6. Kielbassa AM, Muller J, Gernhardt CR. Closing the gap between oral hygiene and minimally invasive dentistry: a review on the resin infiltration technique of incipient (proximal) enamel lesions. Quintessence int. 2009;40(8):663-681.
7. Martignon S, Ekstrand KR, Ellwood R. Efficacy of sealing proximal early active lesions: an 18-month clinical study evaluated by conventional and subtraction radiography. Caries res. 2006;40(5):382-388.
8. Phark JH, Duarte S, Jr., Meyer-Lueckel H, Paris S. Caries infiltration with resins: a novel treatment option for interproximal caries. Compend Contin Educ Dent. 2009;30(3):13-17.
9. Kugel G, Arsenault P, Papas A. Treatment modalities for caries management, including a new resin infiltration system. Compend Contin Educ Dent.2009;30(3):1-10
10. Meyer-Lueckel H, Paris S. Progression of artificial enamel caries lesions after infiltration with experimental light curing resins. Caries res. 2008;42(2):117-124.
11. Graham L, Cohn C, Lambert D. Surface layer erosion of natural lesions with phosphoric and hydrochloric acid gels in preparation for resin infiltration. Caris Res 2007:41(3):223-230.
12. Cohn C. ICON treatment of post orthodontic white spot lesions. Oral Health . 2013;103:48-56.
13. Altarabulsi MB, Alkilzy M, Splieth CH. Clinical applicability of resin infiltration for proximal caries. Quintessence int. 2013;44(2):97-104.
14. de Barros L, Apolonio FM, Loguercio AD, de Saboia V. Resin-dentin bonds of etch-and-rinse adhesives to alcohol-saturated acid-etched dentin. J adhes dent. 2013;15(4):333-340.
15. Paris S, Lausch J, Selje T, Dorfer CE, Meyer-Lueckel H. Comparison of sealant and infiltrant penetration into pit and fissure caries lesions in vitro. Journal of dentistry. 2014;42(4):432-438.
16. Vanderas AP, Manetas C, Koulatzidou M, Papagiannoulis L. Progression of proximal caries in the mixed dentition: a 4-year prospective study. Pediatr dent. 2003;25(3):229-234.
17. Meyer-Lueckel H, Chatzidakis A, Naumann M, Dorfer CE, Paris S. Influence of application time on penetration of an infiltrant into natural enamel caries. Journal of dentistry. 2011;39(7):465-469.
18. Gugnani N, Pandit IK, Gupta M, Josan R. Caries infiltration of noncavitated white spot lesions: A novel approach for immediate esthetic improvement. Contemp clin dent. 2012;3(Suppl 2):S199-202.
19. Yetkiner E, Özcan M, Wegehaupt FJ, Wiegand A, Eden E, Attin T. Effect of a low-viscosity adhesive resin on the adhesion of metal brackets to enamel etched with hydrochloric or phosphoric acid combined with conventional adhesives. J adhes dent. 2013;15(6):575

Corresponding Author:
Dr.Sukriti Gupta,
PG Student
Dept. of Pedodontics & Preventive Dentistry,
Rama Dental College, Hospital & Research Centre, Kanpur, U.P, India
Contact no: 08960419935
Email: sukuddoc@gmail.com

How to cite this article: Katiyar A, Kohli A, Singh G, Gupta K, Gupta S, Srivastava S. Caries Prevention – Newer Horizons: A Review. Rama Univ J Dent Sci 2016 Sep;3(3):11-15.

Sources of support: Nil **Conflict of Interest**: None declared