

## Review Article

### Resin Infiltration: Microinvasive Dentistry- A Review

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#### ABSTRACT:

**Aim:** The objective of this review was to outline the theoretical basis, fundamentals, and clinical uses of resin infiltration for carious lesions and enhance aesthetics by reducing the opacity of a tooth's developmental abnormalities. **Background:** The use of resin infiltration as a conservative treatment for non-cavitated, smooth-surface carious lesions was initially described in the 1970s. A micro-invasive procedure called caries infiltration is used to halt non-cavitated caries lesions. The technique is based on inserting so-called infiltrant, low-viscosity light-curing resins, into the pores of the enamel lesion. Interproximal caries is typically treated with invasive restorative procedures as well as non-invasive therapies including fluoride, food restriction, and dental hygiene education. Alternatives to the pit-and-fissure sealing on occlusal surfaces, which has been demonstrated to be successful in preventing. Neither have been developed on the surfaces of the interproximal joints, preventing caries. Recently, research into and advancements in the use of resins on interproximal caries lesions led to the creation of novel materials that penetrate and seal the carious lesion, enhancing the inhibition of caries growth.

**Keywords:** Resin infiltration technique, white spot lesions, smooth surface caries, non-cavitated carious lesions and minimal invasive technique.

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#### INTRODUCTION

Dental caries care has seen a significant transformation in recent years, evolving from the conventional restorative treatment method and towards a preventive approach with no or limited invasion. No cavity design or restorative material can cure caries, it is universally acknowledged in modern dentistry. Certainly, once there is a cavitation on the enamel surface, surgical intervention will be justified in these circumstances.<sup>(1)</sup>

Patients place a high value on tooth aesthetics, with tooth colour being of particular relevance. Patients' self-esteem suffers as a result of discoloured teeth, and they are more cautious to smile.<sup>(2)</sup>

Minimally invasive techniques (restricted to the actual damage) lessen the amount of destruction, biomimetic restorative materials (imitating nature while adhesively luted) allow for a satisfying clinical and aesthetic outcome, and concurrently, the intervention will enable control of the local microflora (by altering the local environment, thereby revealing that

operative and restorative dentistry is but a true part of prevention).<sup>(3)</sup>The term "minimal intervention dentistry" (MID) refers to an alternative to the standard surgical approach to treating dental caries, which was developed more than a century ago and is based on the operative concepts of G.V. Black.

#### PRINCIPLES OF MINIMAL INTERVENTION

Control the disease by reducing cryogenic bacteria.

- Restorative dentistry will only work if there is no disease.<sup>(4)</sup>
- To evaluate the possibility of carious activity, proper diagnostic procedures must be performed on each at-risk patient.<sup>(4)</sup>
- Several oral lavages are available to change the balance of the oral flora, but chlorhexidine is probably the most efficient of these. Modification of the oral microflora is crucial in the first stage.<sup>(4)</sup>
- MID is a dental treatment strategy that attempts to maintain teeth's lifetime functionality. As a

result, this phrase is applicable to various aspects of oral health, such as periodontology, oral rehabilitation, and oral surgery, rather than just the management of dental caries.<sup>(5)</sup>

In recent decades, it has been widely explored how to cease and control the early carious lesions in a way that is considerably more tissue-conserving, by resin Infiltration.<sup>(6)</sup>

For infiltration, a variety of materials have been employed in the past. 2009 witnessed the introduction of resin infiltrant—Icon in Germany. The proximal and vestibular regions are the target areas for the microinvasive therapy of early carious lesions, according to the product's manufacturers. It can be used to efficiently treat caries without drilling.

Therefore, the purpose of this review was to evaluate the concepts, scientific foundation, and clinical uses of resin infiltrants.<sup>(7)</sup>

**MATERIALS AND METHODS**

ICON's caries infiltration bridges the gap between prophylaxis and filling. ICON works on the infiltration principle and requires a fairly dry field. Additionally, it optically obscures the lesion with healthy enamel, making it possible to employ cutting-edge techniques for front teeth treatments where aesthetics are significant.

The method for infiltration is easy. Following pre-treatment with Icon Etch, Icon Infiltrant, a fluid resin, is then applied to the affected region. The Infiltrant penetrates deeply into the porous enamel by capillary action, afterwards, it is light-cured. The area which is infiltrated gradually takes up the appearance of the surrounding enamel.<sup>(8)</sup>



**Fig no. 1: DMG's ICON for resin infiltration for treatment of enamel and interproximal lesions**

**THE INFILTRATION TREATMENT STEPS:**

**STEP 1: ICON ETCH:** To prepare the surface, a rubber cup and prophylaxis paste were used to clean the tooth surface.

Incorporate the HCl-Gel into the affected areas using, an applicator tip to remove the surface layer that

appears to be intact. The infiltrant can enter the tooth's pore system once this layer has been properly removed. If necessary, the etching procedure can be repeated up to two more times. **(Fig no. 2)**



**Fig no. 2: DMG-ICON's etch is applied on the labial surface of the anterior teeth**

**STEP 2: ICON DRY**

For visual inspection and to provide a last coat of protection, Icon-Dry; DMG (ethanol) and air are used to dry the lesion. **(Fig no. 3)**



**Fig no. 3: DMG-ICON's dry and air to dry the lesion.**

**STEP 3: ICON INFILTRANT**

Apply the infiltrant; DMG and enable the capillary action allowing it to penetrate deep into the enamel. After that, light cure for 40 seconds on each side. Similar to healthy enamel, the infiltrating lesion has similar mechanical and optical characteristics. **(Fig no. 4)**



**Fig no. 4: DMG-ICON'S infiltrant is applied after drying the enamel surface**



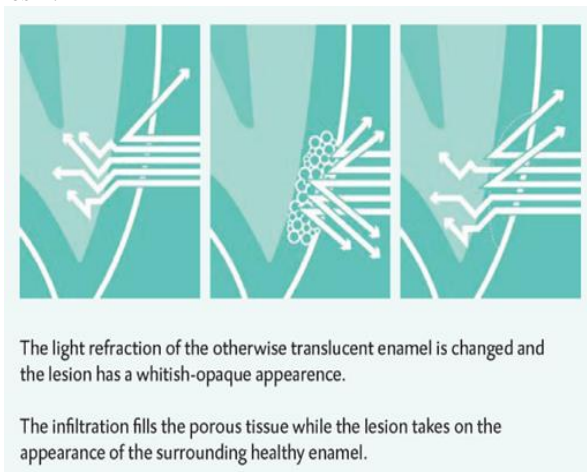
**Fig no. 5: Before and after the application of DMG’s ICON in the patient with fluorosis since 5 years.**

**RESULTS**

**CONCEPTS OF RESIN INFILTRATION**

Resin infiltration is an innovative approach for treating carious lesions that bridges the gap between prevention and repair.<sup>(9)</sup>This minimally invasive procedure stabilises, fills, and strengthens demineralized enamel without drilling into healthy tooth structure. The proximal and smooth surface carious lesion can be treated with this micro-invasive infiltration up to the first third of the dentin. It is available as proximal surface and vestibular surface kits under the brand name Icon® (DMG America Company, Englewood, NJ).<sup>(3)</sup>

Resin infiltration prevents the progression of a lesion by occluding the micro porosities that could serve as diffusion pathways for acids and dissolved materials. It operates on the theory of perfusing porous enamel with resin through capillary action.<sup>(5)</sup>The appearance of the surrounding healthy enamel is mimicked by the white spot lesion once it has been infiltrated by the resin.<sup>(9)</sup>



**Fig no. 6: resin infiltration mechanism**

**ADVANTAGES OF RESIN INFILTRATION**

Clinical dentistry's mainstay is still making decisions relating to caries.

However, the majority of dentistry is still restorative dentistry (requiring ongoing restorative procedures throughout the patient's lifetime), and traditional core skills, as well as manual dexterity and technical competence, have less to offer to oral health than many clinicians are used to believing. It is obvious from the review that follows that the resin infiltration method has a number of benefits.<sup>(3)</sup> These are as follows:

1. Maintenance of sound hard material (protection of the tooth in question as well as the tooth next to it)
2. Demineralized enamel is mechanically stabilised,
3. Superficial micropores and cavities are permanently filled,
4. Porous, profoundly demineralized portions are obstructed.
5. Delay of restorative intervention for longer periods of time
6. Minimised risk of secondary caries
7. Reduced risk of gingivitis and periodontitis
8. No danger of postoperative sensitivity and pulpal irritation
9. When used as a "masking" resin on demineralized labial surfaces (white spot lesions, for example with orthodontic patients), the aesthetic effect is improved.
10. Lesion progression is also prevented.
11. Significant patient approval

**DISADVANTAGES OF RESIN INFILTRATION**

1. The initial lesion's necessity for surface conditioning is a drawback of resin infiltration. Because natural early caries lesions have a hyper-mineralized surface layer that prevents resin from penetrating the demineralized body of the lesion, surface conditioning with 15% hydrochloric acid is required.<sup>(10)</sup>
2. Phosphoric acid is less effective than hydrochloric acid and causes less thorough infiltration, according to comparative research. The resin's excessive hydrophobicity is another issue. The resin must therefore be applied in completely dry conditions. Resin penetration is further hampered by the lesion's body having been wet.<sup>(10)</sup>
3. Difficulty in retention and high flow ability when applied, in addition to the need for smooth proximal surfaces<sup>(1)</sup>
4. The probability of achieving a full infiltration will decrease with increasing carious lesion depth.<sup>(9)</sup>
5. Greater polymerization shrinkage and the ensuing development of porosities and fissures are also linked to extensive lesions. Considering the limited capillary activity of the resin in these lesions, the infiltration of cavitated lesions does not yield adequate results.<sup>(9)</sup>



## INDICATIONS OF RESIN INFILTRATION

1. Amelogenesis imperfecta
2. Molar incisor hypomineralization,
3. Fluorosis
4. White spot Lesions <sup>(9)</sup>

## CONTRAINDICATIONS OF RESIN INFILTRATION

Resin Infiltration technique is contraindicated in cavitated lesions but instead is a treatment option in non cavitated incipient (interproximal) enamel lesions. The problem in posterior teeth is the bitewing radiograph does not give any direct information on the surface integrity of proximal lesions. <sup>(11)</sup>

## DISCUSSION

The treatment of early carious lesions with resin infiltration is a novel approach in the minimal intervention dentistry philosophy. Caries/Resin infiltration is a novel technique for the treatment of non-cavitated lesions of the proximal and smooth surfaces of deciduous and permanent teeth up to the first third of dentin. <sup>(9)</sup> Attempts have been made for decades to infiltrate primary caries lesions with resin in order to inhibit further caries progression rather than excavating those lesions and inserting fillings. <sup>(10)</sup> Disturbances during enamel development are the root cause of fluorosis, traumatic hypo calcification and molar-incisive hypo-mineralization (MIH) and the caries related post-eruptive discoloration is referred to as white spot lesions (WSL). <sup>(12)</sup>

Resin infiltration is a minimally invasive procedure that fills incipient lesion pores through capillary action, which prevents lesion development by creating barriers to prevent bacterial diffusion, restores the tooth without anesthesia and drilling, and preserves the tooth's natural anatomy. <sup>(13)</sup>

Application of topically remineralizing agents, micro-abrasion, topical fluoride application and bleaching are attempted to stop enamel demineralization and/or to enhance tooth aesthetics. <sup>(12)</sup> Modern dentistry includes minimal intervention because it focuses on preventive or non-surgical measures to protect dental hard tissues, avoiding any unintended loss of tooth structure and guaranteeing prolonged tooth survival. <sup>(9)</sup>

The aim of resin infiltration is to use low-viscosity resins to obstruct the highly porous enamel lesion's early structures. The possible caries-inhibiting action of resin infiltrants works by occluding the pores within the lesion's body, in contrast to the sealing of caries lesions, which depends on the exterior occlusion of the lesion with the sealant material. <sup>(9)</sup> A low-viscosity resin that easily flows into an etched enamel substructure is used in resin infiltration therapy. <sup>(14)</sup>

The initial demineralization of a caries process increases porosity, which alters the refractive index of enamel and causes the early lesion to appear white. Another benefit of the resin infiltration approach is

that the lesion's whitish look can be changed to that of natural enamel thanks to the low viscosity resin's penetration and polymerization inside the lesion body. <sup>(9)</sup> The substance is light-cured after it has penetrated into the enamel subsurface. The resin's refractive index is quite similar to enamel's. <sup>(14)</sup>

This ultraconservative method successfully creates a covalently bound three-dimensional polymer framework, (partially) replacing the lost minerals, encasing the crystals of hydroxyapatite, micromechanically interlocking the remaining enamel prisms, and acting as an efficient barrier for hydrogen ions to prevent further demineralization and to hinder the progression of subsurface lesions. <sup>(9)</sup> A lesion has to be completely infiltrated so as to maintain the enamel stability.

The penetration coefficient of a light-curing resin can be used to forecast how well it would penetrate enamel defects. Determining the penetration coefficient, therefore, appeared to be a suitable method for estimating the penetrability of possible infiltrators. <sup>(4)</sup>

Carious lesions' microhardness increased is with resin infiltration. This is certain because of a uniform complex made of triethylene glycol dimethacrylate (TEGMA) and hydroxyapatite, which interacts with crystals to improve mechanical strengths and aesthetic appearance. <sup>(15)</sup>

Surface roughness, microhardness, and shear bond strength are all considerably altered by resin penetration in sound enamel and white spot lesions. Resin infiltration reduce the surface roughness, microhardness, and shear bond strength of sound enamel by 35%, 24%, and 25%, respectively. After applying infiltrative resins to White spot lesions, enamel surface roughness decreased by 54%, while microhardness and shear bond strength increased by 68% and 89%, respectively. <sup>(16)</sup>

The researchers reported that because developmental opacities have a thicker surface, comparable to inactive decay lesions, they cannot be completely repaired by resin infiltration methods. <sup>(9)</sup>



**Fig no. 7: Another before and after of resin infiltration on fluorosis patient with DMG's ICON.**

On the other hand, Microabrasion and macroabrasion both have been used since the early 19th century, to manage superficial enamel flaws aesthetically, a combined chemomechanical technique is used. It is the least intrusive cosmetic procedure, but alternative restoration methods like composite, veneers, or crowns have overshadowed it. <sup>(2)</sup>A controlled procedure called enamel macro-abrasion is used to remove enamel to treat discolorations that only affect the exterior enamel layer. The technique of enamel microabrasion involves applying hydrochloric acid and pumice in a paste form to the affected tooth surfaces to remove up to 100 m of surface enamel, through the use of a combination of erosion and abrasion. <sup>(17)</sup>

Though reasonably effective, micro- and macroabrasion has the potential to remove more tooth structure than is necessary or wanted.

The management of dental fluorosis has been demonstrated to be successful when the resin infiltration approach is used in conjunction with bleaching and microabrasion techniques. <sup>(18)</sup>

## CONCLUSION

This review found that the resin infiltration approach appears to be an effective choice for colour masking of enamel whitish discolorations, arising from both white spot lesions and enamel development faults, based on the scientific data now available.

Initial caries lesion arrest seems to be possible with the use of appropriate materials that have a high level of resistance to mechanical and chemical deterioration, as well as with careful application techniques. This would bridge the gap between oral hygiene and minimally invasive dentistry.

This indicates that Resin infiltration in Minimal invasive dentistry is a potentially effective non-invasive therapy method and might be regarded as a better choice to non-surgical and operational treatment methods. <sup>(3)</sup>

## REFERENCES

- Meyer-Lueckel H, Paris S. Improved resin infiltration of natural caries lesions. *J Dent Res.* 2008 Dec;87(12):1112-6. doi: 10.1177/154405910808701201. PMID: 19029077.
- Shenoi, Pratima & Kandhari, Archana & Gunwal, Mohit. (2023). Esthetic Enhancement of Discolored Teeth by Macroabrasion/Microabrasion and its psychological impact on patients -A case series.)
- 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 Sep;40(8):663-81. PMID: 19639091.
- Nivashini, G. S. V. 2017. "Resin infiltration technique – A review", *International Journal of Current Research*, 9, (04), 49267-49269.
- 3 Paris S, Schwendicke F, Keltsch J, Dörfer C, Meyer-Lueckel H. Masking of white spot lesions by resin infiltration in vitro. *J Dent.* 2013 Nov;41 Suppl5:e28-34. doi: 10.1016/j.jdent.2013.04.003. Epub 2013 Apr 11. PMID: 23583919
- Paris S, Meyer-Lueckel H, Kielbassa AM. Resin infiltration of natural caries lesions. *J Dent Res.* 2007 Jul;86(7):662-6. doi: 10.1177/154405910708600715. PMID: 17586715.
- Crombie F, Manton D, Palamara J, Reynolds E. Resin infiltration of developmentally hypomineralised enamel. *Int J Paediatr Dent.* 2014 Jan;24(1):51-5. doi: 10.1111/ipd.12025. Epub 2013 Feb 15. PMID: 23410530
- <https://www.dmg-america.com/en/products/product/icon/> - Product catalogue.
- S, Karthika & George, Sageena & S, Anandaraj & Nair, Lekshmy. (2020). Resin infiltrants- A new era in minimal intervention dentistry. *International Dental Journal of Student Research.* 8. 100-107. 10.18231/j.idjsr.2020.021.
- Arnold, Wolfgang H et al. "Resin infiltration into differentially extended experimental carious lesions." *The open dentistry journal* vol. 8 251-6. 29 Dec. 2014, doi:10.2174/1874210601408010251
- <https://www.styleitaliano.org/posterior-resin-infiltration-and-direct-vision/#:~:text=Resin%20infiltration%20technique%20is%20contraindicated,surface%20integrity%20of%20proximal%20lesions.>
- Borges AB, Caneppele TM, Masterson D, Maia LC. Is resin infiltration an effective esthetic treatment for enamel development defects and white spot lesions? A systematic review. *J Dent.* 2017 Jan;56:11-18. doi: 10.1016/j.jdent.2016.10.010. Epub 2016 Oct 25. PMID: 27793705.
- Paris S, Hopfenmuller W, Meyer-Lueckel H. Resin infiltration of caries lesions: an efficacy randomized trial. *J Dent Res.* 2010 Aug;89(8):823-6. doi: 10.1177/0022034510369289. Epub 2010 May 26. PMID: 20505049.
- Leland A, Akyalcin S, English JD, Tufekci E, Paravina R. Evaluation of staining and color changes of a resin infiltration system. *Angle Orthod.* 2016 Nov;86(6):900-904. doi: 10.2319/111615-777.1. Epub 2016 Apr 6. PMID: 27049735; PMCID: PMC8597324.
- Kim S, Kim EY, Jeong TS, Kim JW. The evaluation of resin infiltration for masking labial enamel white spot lesions. *Int J Paediatr Dent.* 2011 Jul;21(4):241-8. doi: 10.1111/j.1365-263X.2011.01126.x. Epub 2011 Mar 14. PMID: 21401750
- Soveral, Madalena et al. "Effect of Resin Infiltration on Enamel: A Systematic Review and Meta-Analysis." *Journal of functional biomaterials* vol. 12,3 48. 16 Aug. 2021, doi:10.3390/jfb12030048
- Lynch CD, McConnell RJ. The use of microabrasion to remove discolored enamel: a clinical report. *J Prosthet Dent.* 2003 Nov;90(5):417-9. doi: 10.1016/s0022-3913(03)00503-1. PMID: 14586302.
- Saxena P, Grewal MS, Agarwal P, Kaur G, Verma J, Chhikara V. Clinical Efficacy of Resin Infiltration Technique Alone or in Combination with Micro Abrasion and in-Office Bleaching in Adults with Mild-to-Moderate Fluorosis Stains. *J Pharm Bioallied Sci.* 2021 Jun;13(Suppl 1):S301-S305. doi: 10.4103/jpbs.JPBS\_795\_20. Epub 2021 Jun 5. PMID: 34447098; PMCID: PMC8375862.