Ministry of higher Education And Scientific Research

University of Babylon College of Dentistry

Resin infiltration technique

A research submitted to the department of conservative dentistry , in the college of Dentistry , University of Babylon , ***as a partial requirement of degree of Bachelors (B.D.S)***

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الاهداء الى

العائلة حفظها الله

الى كل الاصدقاء , و من كانوا برفقتنا اثناء الدراسة في الجامعة

و الى كل التدريسين الذين لم يذخروا جهداً في مساعدتنا

و الى كل من ساهم في تلقينا العلم و لو بحرف واحد في حياتنا الدراسية

و الى العلم ..... و رواده ..... و طلابه

شكر وتقدير

قال تعالى (ومن يشكر فإنما يشكر لنفسه) { لقمان :12 }

وقال رسوله الكريم ﷺ : "من لم يشكر الناس ، لم يشكر الله عز وجل"

نحمد الله تعالى حمداً كثيراً طيباً مباركاً ملئ السموات والأرض على ما أكرمنا به من إتمام هذه الدراسة التي أرجو أن تنال رضاكم . ثم أتوجه بجزيل الشكر وعظيم الامتنان إلى كل من :-

الدكتورة الفاضلة آيات الهاشمي / لتفضلها الكريم بالأشراف على هذه الدراسة , و تكرمها بنصحنا و التوجيه للإتمام

الباحثين

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Introduction

Resin infiltration technique is a novel technology that bridges the gap between prevention and restoration of carious lesions up to the first third of dentin (D-1) and can camouflage aesthetically disfiguring white lesions on the buccal surface. It is marketed under the name Icon® (DMG America Company, Englewood, NJ) and is described as a micro-invasive technology that fills, reinforces, and stabilizes demineralized enamel without sacrificing the healthy tooth structure

DMG(3De max gel (etching gel)) is celebrating ten years of helping dental professionals treat incipient caries and white spot lesions with its revolutionary Icon Caries Infiltrant.

Prior to the caries infiltrant's inception, clinicians had only two options upon discovering incipient caries: using fluoride and other treatments in an often-futile attempt to remineralize enamel, or simply waiting until it became time to drill and fill. With the advent of Icon, they could now immediately and micro-invasively fill and reinforce demineralized enamel without drilling or anesthesia.

For the last 10 years, Icon has offered dental professionals and their patients a significant advantage over fluoride therapy, which is not always effective when caries have advanced to the stage of discovery. Equally important, Icon has made it unnecessary to sacrifice healthy tooth structure with drilling. Instead,it is now possible to arrest the progress of early enamel lesions in up to the first third of dentin in one simple procedure.

Soon after its 2009 launch, numerous clinical studies confirmed that Icon is also effective for the cosmetic treatment of cariogenic white spots on smooth surfaces. Lesions infiltrated by Icon take on the appearance of the surrounding healthy enamel, thereby providing a highly esthetic, single-treatment alternative to micro-abrasion and restorative treatments of cariogenic white spots. According to Timothy Hess, DDS,

“White spots are a major issue for my post-orthodontic patients. Icon enables me to remove them in one simple, painless treatment. It’s a ‘wow’ moment for the patient, and a significant source of growth for my practice Resin infiltration is a technique that has been available as a commercial product since 2010. The procedure consists of etching the tooth with a 15% hydrochloric acid, drying with an ethanol solution, and applying a TEGDMA-based resin infiltrant (Triethylene glycol dimethacrylate) . The product (ICON, DMG) was initially developed as a treatment for incipient interproximal caries and anterior white spot lesions. Clinical experience with this technique, however, revealed that it is also effective in masking enamel discoloration of non-carious origin. This reportwill summarize the diagnosis of discolorations that may be treated with resin infiltration, the mechanism of action of the resin infiltration product, and a clinical protocol for the use of resin infiltration to treat an anterior tooth discoloration of developmental origin ; Resin infiltration is a minimally invasive restorative treatment to treat white-spot lesions on your teeth. They usually appear as.

To perform ICON resin infiltration treatment, the dentist will remove the outer layer of enamel that is blocking the calcium and other ions to penetrate the tooth and replace it with a different substance. The treatment is quick and minimally invasive...

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.
A positive side effect of resin infiltration is that enamel lesions lose their whitish appearance when their microporosities are filled with the resin and look similar to sound enamel. The principle of masking enamel lesion

ICON Resin Infiltration treatments are done in one dental visit and don't require shots, numbing, or drilling. The entire process usually takes anywhere from 45 minutes to an hour.

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etiology Discolorations

Discolorations seen on dental enamel can be attributed to either a caries-induced or non-carious etiology. Discoloration from changes in enamel formation initiated by caries are known as "white spot lesions" or "decalcification lesions." Decalcification lesions typically are located at the cervical aspect of the tooth or surrounding orthodontic brackets because these surfaces are more likely to accumulate acid-producing plaque. The incidence of decalcification lesions during orthodontic treatment has been reported to be as high as 50%-97%.Decalcification lesions also may be suspected based on the patient's caries risk. Patients with poor oral hygiene, a diet that lowers intraoral pH, a lack of fluoride, or a history of orthodontic treatment may be more likely to acquire decalcification lesions seen as white spots. Diagnosing the true etiology of a non-carious tooth discoloration is often difficult. Some clinicians (and patients) will attribute all non-carious tooth discolorations to fluorosis. Fluorotic lesions are brown or white discolorations caused by exposure to excess fluoride during the years of amelogenesis.

According to the Centers for Disease Control and Prevention, the prevalence of some form of fluorosis affected about 23% of Americans during period from 1999 to 2004. Severity and manifestation of the fluorosis stain vary, and about 7% of the population were categorized with a form of fluorosis with visibly apparent lesions (mild, moderate, or severe). Many discolorations are not caused by fluorosis, and some may be idiopathic white or brown enamel discolorations formed during development. Croll has coined the term "dysmineralization" to describe these disturbances in the

formation of the inorganic component of enamel. A history of trauma, high fever episodes, or medications taken during childhood may be responsible for altering the enamel mineralization process and lead to discoloration. Discolorations attributed to systemic conditions should be present on all teeth mineralizing at the same time during development, whereas those caused by trauma may be limited to a single tooth. Common components of our diet can be extrinsic causes of stains, such as coffee, tea, soy sauce, red wine, or an iron supplement in vitamins, as well as some dental products such as chlorhexidine and stannous fluoride. The clinician should ask the patient about the onset of appearance of the discoloration. A discoloration that has developed during the patient's span of memory is more likely to be extrinsic staining than is one that has to do with tooth development. In the author's experience, treatment of extrinsic staining from diet or dental products may be accomplished with a dental cleaning or enamel microabrasion.

Resin infiltration has been shown to be able to mask discoloration from both decalcification lesions and those of developmental non-carious etiology. In the clinical trials examining resin infiltration of decalcification lesions following orthodontic brackets, lesions were infiltrated at an average time of 5 months,months,12 or 21 months9 after removal of orthodontic brackets depending on the trial. One of the trials reported that there was no association between time from debonding to infiltration with the improvement in appearance of the lesion.

In a clinical trial, 11 out of 18 teeth (61%) with decalcification lesions were completely masked, whereas, only five out of 20 teeth (25%) with non-carious discolorations were completely masked. In a laboratory study, resin infiltration was shown to have variable results with different hypomineralized enamel lesions of developmental origin. Another clinical trial reported better masking effects for lesions attributed to fluorosis than those attributed to hypomineralization. A practical

consideration for treating non-carious discolorations is determining the thickness of the discoloration. A thicker discoloration is more visually apparent and will be more difficult to infiltrate and mask. A method to help determine the thickness of a stain is to transilluminate the tooth with a dental transilluminator or light-curing unit (with proper eye protection). If the lesion becomes significantly darker with transillumination, the lesion is likely deeper within the enamel.

White spot lesions

White spot lesions are defined as the enamel lesions that look chalky white and opaque. It can arise from developmental cause such as fluorosis, idiopathic cause or early caries lesion. Incipient caries, one of the white spot lesions, is the enamel caries lesion that can be clinically recognized for the first time. white spots on the teeth and are also referred to as hypo spots or enamel bruising. These white lesions are usually caused by enamel defects, trauma, or infection to the primary teeth and results from decreased access of calcium and other ions to the deeper portions of the enamel on the tooth-eventually resulting in white spots on the external surface of the tooth

White spot lesions develop as a result of a dietary carbohydrate and saliva modified bacterial infection, resulting in an imbalance between demineralization and remineralization of the enamel. And these are generally considered to be the precursor of frank enamel carious lesions. The white appearance is due to an optical phenomenon which is caused by mineral loss in the surface or subsurface enamel. Enamel crystal dissolution begins with subsurface demineral- ization, creating pores between the enamel rods. The resultant alteration of the refractive index in the

affected area is then a consequence of both surface roughness and loss of surface shine and alterations in internal reflection, all resulting in greater visual enamel opacity, as porous enamel scatters more light than sound enamel.

In regard to the prevalence of white spot lesions, it has been reported that there is a significant increase in the prevalence and severity of enamel demineral- ization after orthodontic treatment. The overall prevalence of white spot lesions amongst orthodontic patients has been reported as anywhere between 2 and 96 percent. Some white spot lesions may rem- ineralize and return either to normal or at last to a visually acceptable appearance. However, white spot lesions may also persist, resulting in an aesthetically unacceptable result.

Several techniques have been proposed to improve the appearance of white spot lesions. The common treatment strategy for white spot lesions comprises restorative procedures, improvement of remineraliza-tion using CCP-ACP(is a milk product which helps in remineralization and prevents dental caries) containing or fluoride containing products, microabrasion, argon-laser irradiation. Recently,'resin infiltration technique'was intro- duced with the development of highly-flowable resin material. The following case report describes the effect of resin infiltration technique to mask white spots that was detected after debonding of fixed orthodontic appliance and calculus removal

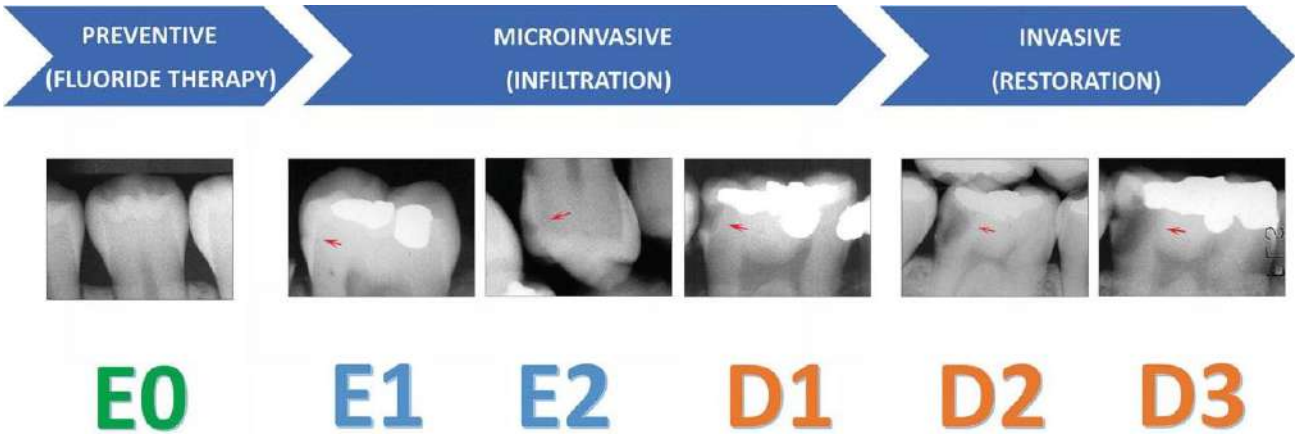
Caries affects children's overall health, development, and quality of life because it and the associated pain and effects on facial estheticscan compromise critical factors such as the ability to eat and sleep, self-esteem, social and speech development, and success in school. In fact, childhood caries can have a lifelong effect on patients' oral, general, and emotional health.

The appearance of visible white-spot lesions indicates that enamel demineralization and the caries process are underway. Both children and adults, especially those undergoing orthodontic treatment, are susceptible to incipient smooth-surface and interproximal carious lesions, even if they exhibit good oral hygiene. Numerous adjunctive preventive therapies, from fluoride rinses and varnishes to frequent

professional cleanings and the use of xylitol-containing products, can be used to reduce the incidence of incipient carious lesions in primary and permanent teeth.

However, when interproximal or white-spot lesions occur, they can cause structural, functional, and esthetic issues. Treating these lesions in the early stages should begin with minimal therapy options such as high-concentration topical fluoride, fluoride varnish, remineralization, microabrasion, and resin infiltration.

Icon is a treatment option that falls between fluoride therapy and the “wait-and- see” then “drill-and-fill” approach once carious lesions become large enough to treat. Even ultraconservative restorative treatment removes more healthy tooth structure than may be necessary to arrest caries. Icon can be used in lesion depths of enamel 1 (E1), enamel 2 (E2), and dentin 1 (D1). Restorative procedures may be required for dentin 2 (D2) and dentin 3 (D3) lesions, as well as cavitated enamel.



The Icon infiltrant is a low-viscosity hydrophilic resin material designed to infiltrate a smooth-surface or interproximal lesion, block its progression, and arrest its development at an early stage. Drilling and anesthesia are not necessary, and treatment requires only a single visit.

The protocol involves preparing the smooth-surface lesions by abrading lightly with a disk (optional), then using a 15% hydrochloric acid (Icon-Etch, DMG) to etch the

surface of the tooth. Ethanol alcohol (Icon-Dry, DMG) is then applied to show a preview of the final result. If the preview is not satisfactory, etching a second and possibly a third time may be needed. Next, the resin (Icon-Infilrant, DMG) is brushed onto the lesion, allowed to penetrate (≤ 800 micrometers in depth), light cured, and finished. The infiltrant can be applied for up to 3 minutes before light curing to reach the desired level of infiltration. For deeper lesions, the first application of the infiltrant may be left on longer than 3 minutes. After light curing, the infiltrant creates a diffusion barrier within the hard tissue that stabilizes the caries, cutting off its supply of nutrients and oxygen

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Indication

1- Low salivery sacration (high caries risk patient done and showed both a low buffering capacity and a low flow rate)

2- a tooth crowding Despite appearing to be a high caries risk patient, she showed such that orthodontic interceptive treatment was to be carried out.

3- aesthetically traeted tooth Even brown spots, which have developed over a longer period of time,as long as the surface is not cavitated.

4- as pravantion Measurements Resin infiltration with Icon leads to a caries arrest at an early stage and disappearance of white spots.

5- Indication for patient after orthodontic treatment


White spot lesions, a common problem following orthodontic treatment. Picture credit: Dr Padraig Fleming

6- Micro-invasive treatment of non-cavitat-ed dental enamel lesions (lesion depth up to D1*).

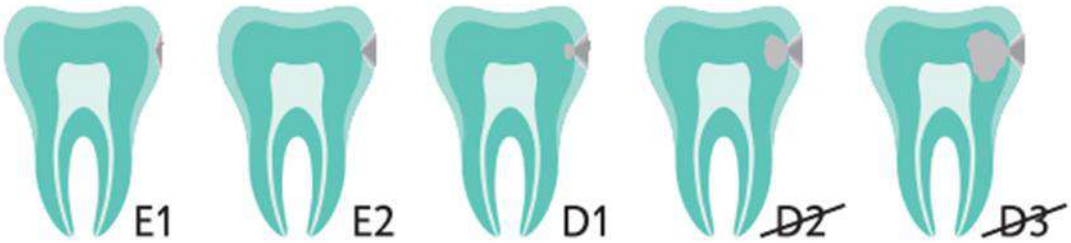
Scores		Criteria
E1		Radiolucency confined to the outer half of enamel.
E2		Radiolucency in the inner half of the enamel including lesions extending up to but not beyond the enamel-dentin junction.
D1		Radiolucency in the dentin; beyond enamel-dentin junction but within the outer third of dentin.
D2		Radiolucency with obvious extension into the second third of dentin.
D3		Radiolucency with obvious extension into the inner third of dentin.

7- Mild fluorosis

Contraindications

Do not use this material:

1- for deeper seated lesions (D2 – D3)



* Radiographic lesion depth classification according to bite wing images.

2- on cavitated enamel (enamel defects).

3- in case of known allergies to any material component or existing contact allergies.

4- The patient has terrible oral hygiene habits

5- If the patient uncoopreative

6- moderate to severe fluorosis

the benefits of Icon dental resin infiltration

1- Pain-free.
2- Involves no drilling.
3- Performed in-clinics.
4- Prevents dental cavities at an early stage
5- Preserves healthy tooth structure.
6- Gentle therapy for difficult-to-reach proximal cavities (caries located in between teeth)
7- No unnecessary loss of healthy hard tissue
8- in a single visit
9- Mechanical stabilization of demineralized enamel :Deeper penetration into porous demineralized areas
10- Minimized risk of secondary caries
11- No risk of postoperative sensitivity and pulpal inflammation

12- Reduced risk of gingivitis and periodontitis

13- Reimproved esthetic outcome when used as a “masking” resin on labial surfaces (white spot lesions, i.e. with orthodontic patients)

14- High patient acceptance. While this therapy can rightly be categorized as minimum intervention dentistry, clinical experience is limited and further controlled clinical trials are required to assess its long-term results.

15- Healthier smile: free of cavities and white spots.

16- Immediate results.

17- Untreated lesions often look worse after bleaching. Icon treated lesions will whiten similarly to natural tooth enamel.

18- Much less invasive and expensive than fillings or veneers

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Disadvantage

1- the need for surface conditioning of the initial lesion .

2- Every 3 to 6 years the onset of this material is disappear and require for filling because the inability to retreat the tooth by this technique

3- In some cases, contact allergies with similar composite products have been reported.

4- Contact of Icon-Etch with the oral mucosa causes a white surface coloration. This will subside after a few days

5- Extensive lesions are also associated with a higher polymerization shrinkage and the consequent appearance of porosities and cracks

6- ICON works on the principle of infiltration and requires a very dry field.

7- additional steps must be taken
8- The infiltration of cavitated lesions does not produce satisfactory results, taking into account the weak capillary action of the resin into these lesions
9- High leveal of patiante cooperatinve

Mechanism Of Action Of Resin Infiltration

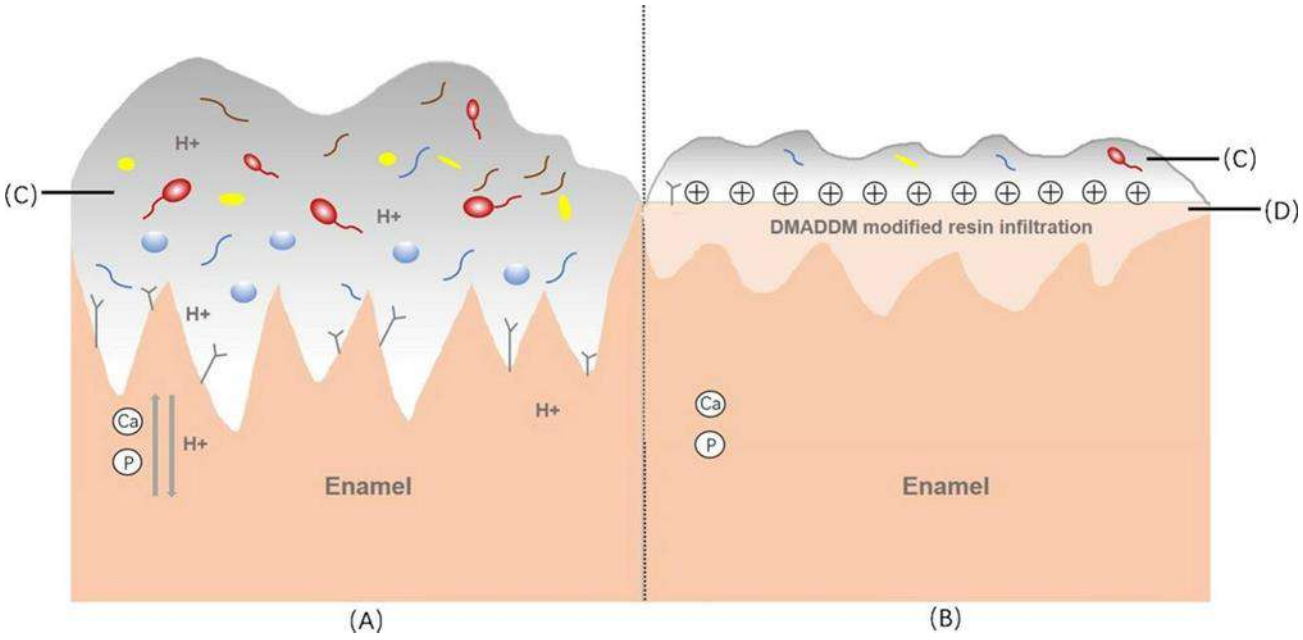
Resin infiltration was developed as a technique to treat enamel caries. The histopathology of enamel caries occurs as acid dissolves inter-crystalline spaces within enamel. Since the outermost 10-30 microns of enamel is more resistant to dissolution from the presence of fluorapatite, a more porous subsurface forms. The principle of resin infiltration for caries arrest is to occlude the porosity formed during the caries process and prevent pathways for acid to further dissolve the tooth structure.

The two basic steps to achieve this goal are to remove the less-porous surface layer of enamel and allow resin to infiltrate the internal enamel porosities through capillary movement. As the surface of a carious lesion may act as a barrier to resin infiltration, several preliminary studies evaluated different acid solutions for removal of the surface layer. A solution of 15% hydrochloric acid applied for 90-120 seconds was shown to almost completely remove the 45-micron thick surface layer of the lesion. After removing the surface layer of the carious lesion, the next step is to infiltrate resin into the porosities created during dissolution of intercrystalline enamel. Unfilled resin infiltrants have been shown to penetrate deeper into carious lesions than dental adhesives and a TEGDMA resin infiltrant was shown to penetrate deeper than other formulations of infiltrants. When applied for three minutes, the ICON TEGDMA-

based infiltrant was shown to penetrate 414 microns into non-cavitated interproximal caries lesions.

The visual change in enamel that arises from enamel caries is due to the air present in the subsurface porosities. The opaque appearance of the white spot lesion occurs because light is scattered within the body of the white spot lesion. Light scattering is caused when light interacts with two substances with different refractive indices. The refractive index of enamel (1.62-1.65) is different than that of air (1.00). Infiltration of the lesions with an infiltrant that has a refractive index of 1.52 is able to mask the lesion Resin infiltration has also been shown to infiltrate hypomineralized enamel of non-carious developmental origin. A laboratory study reported infiltration to an average depth of 0.67 +/- 0.39 mm in hypomineralized enamel lesions. Interaction

Polymerization inhibiting substances such as products containing eugenol (e. g. temporary cements) must not be used in combination with this material



Storage

▶ Store at 2 to 25 °C / 36 to 77 °F!

▶Protect from direct sunlight!

▶ Do not use after the expiration date!

material Composition

• Icon-Etch: Hydrochloric acid, pyrogenic silic- ic acid, surface-active substances

• Icon-Dry: 99% ethanol

• Icon-Infiltrant: Methacrylate-based resin matrix, initiators, additives

Table 1. Characteristics of the materials tested in this study.

Materials	Manufacturer	Lot number	Chemical composition
Icon	DMG, Hamburg, Germany	719664	TEGDMA based resin matrix, initiators – additives
Control Seal	VOCO GmbH, Cuxhaven, Germany	1511400	55% w/w inorganic fillers in a methacrylate matrix (Bis-GMA, TEGDMA)
Grandio Seal	VOCO GmbH, Cuxhaven, Germany	1413195	70% w/w inorganic fillers in a methacrylate matrix (Bis-GMA, TEGDMA)
Filtek™ Supreme XTE	3M ESPE, St. Paul, MN, USA	N595296	Matrix:Bis-phenolAdiglycidylmethacrylate (Bis-GMA),triethylene glycol dimethacrylate (TEGDMA),urethane dimethacrylate (UDMA), bisphenol A polyethylene glycol dietherdimethacylate Filler: silicananofillers (5-75 nm) zirconia/silica-nanoclusters (0.6-1.4 µm)

Diagnosis and treatment guidelines

Patient's history

1. Assessment of the patient’s caries experience and the patient’s current caries risk.
2. Assessment of oral hygiene status and fluoride use.
3. Assessment of nutritional habits, particularly sugar consumption.

Visual/tactile diagnosis

1. Clean the teeth: removal of discolorations and hard and soft deposits.
2. Maintain optimal light conditions for visual inspection.
3. Assessment of the tooth surfaces for structural changes, opacities, surface gloss.
4. Dry the tooth surfaces with air and reassess the quality of the surfaces.
5. The assessment of the quality of the surfaces is done after separation, without pressure using a fine explorer. This will allow even the smallest non-homogeneous areas and micro-cavities to be "felt".
6. In the event of vestibular lesions, localization and the moment at which they are established are essential indicators for the lesion being carious. Carious lesions are mostly localized in the cervical and central coronal third and develop over the course of time e.g. during orthodontic treatment as a result of insufficient oral hygiene or life episodes with insufficient nutritional and/or oral hygiene habits.
7. Assessing the activity of the cavity. Signs and symptoms of active lesions:

• bright color
• opaque, matte appearance
• surface is rough
• plaque retention on the surfac

X-ray diagnosis

Proximal infiltration	Smooth surface infiltration
Radiographic extension up to the outer third of dentin	Active enamel caries lesions
No detectable cavitation	No detectable cavitation
Dry working field achievable	Dry working field achievable
Lesion progression likely	Esthetic impairment

1. Selection of an appropriate bite-wing holder.

2. If possible, use a customized X-ray holder, as this makes it possible to check the progression much more accurately.

3. Position the patient sitting upright in the X-ray unit.

4. Align the tube precisely.

5. When taking the full dental row series, use one exposure for the premolar region and one for the molar region respectively.

6. For findings using the X-rays, whenever possible, use earlier exposures as a comparison.

Illustration 1+2: Radiograph of lesion extension.

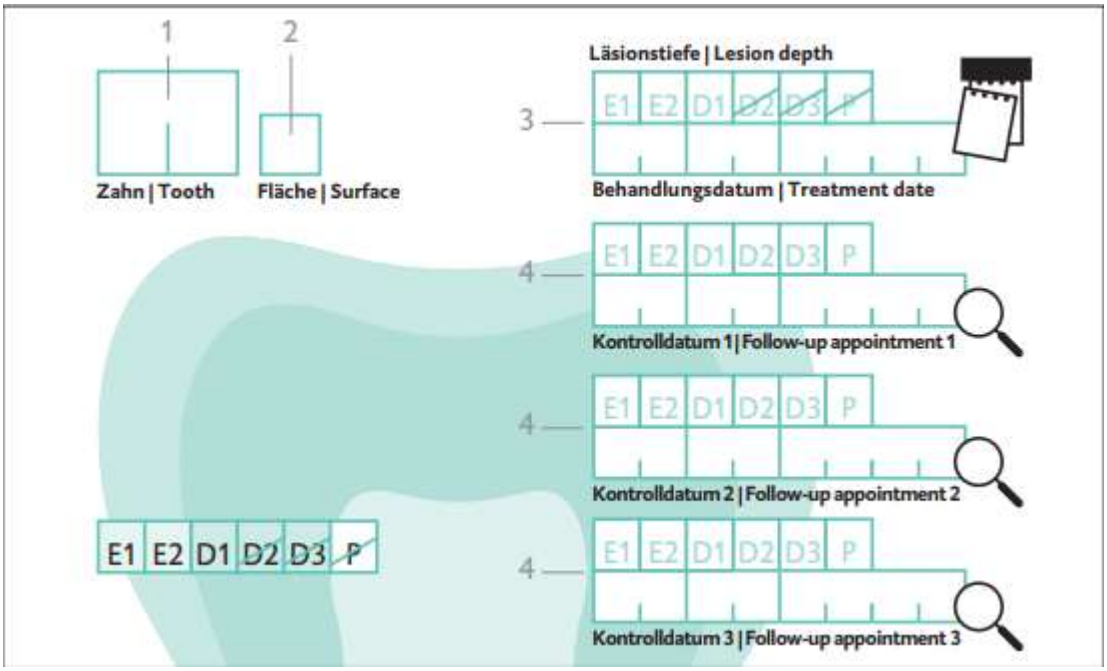
Patient card + sticker

This material is not radiopaque. To document the infiltrated surfaces and lesion depths, the enclosed patient card can be filled out at the time of treatment, follow-up visits, and retained by the patient. In addition, the enclosed sticker supports the documentation in the patient's record.

1. Front: Enter the name of the patient and office stamp.

2. Tooth diagram: Mark the treated area.

3. Record the treated tooth the treated surface (d = distal, m = mesial, v = vestibular (buccal, cervical, labial),) l = lingual or palatal), lesion depth.and the treatment date



Clinical procedure

Isolation of the working field

1. Position the rubber dam proximally.

2. Isolate enough of a working area. The mesial and distal neighboring teeth should also be isolated.

3. Proximal ligatures of dental floss or 4.0 suture material help to keep the rubber dam cervically positioned and to seal the sulcus.

4. Put a vestibular rubber dam in place whenever possible.

5. Sufficient isolation: at least 3 out of 3 in the incisor area, or preferably 4 out of 4.

6. Ligatures of dental silk or suture material should be used to fix the rubber dam at the cervical region of the tooth. Vestibular lesions are mostly to be found in the central and cervical thirds of the crown, so that white cervical edges will frequently be left behind if the isolation is not sufficient.

7. Alternatively, a liquid dam or gingival barrier can be used in the incisor region. Care should then be taken that the dam is applied precisely and no shreds of the material should lie on the surfaces of the tooth.

8. The following procedure has proven its value in practice: apply the liquid dam using a cannula with a large gauge from the mucogingival border up to approx. 1 mm (0.04“) from the neck of the tooth. The cannula is then swapped for one with a small gauge and the remaining strips are filled in up to the neck of the tooth. After the material has hardened, any excess can be removed with a fine scaler

Illustration 3: Isolation using rubber dam and fixation by ligatures.

Illustration 5: Before treatment with Icon.

Illustration 4: Isolation using liquid rubber dam.

Illustration 6: Immediately after treatment with Icon.

Etching

Then neighbouring teeth are isolated with Teflon tape and the etching procedure with hydrochloric acid (Icon-Etch, DMG) starts. The etching is done with a rubbing motion using the special smooth surface (sponge) tip for two minutes. After a lot of rinsing the white spots become even more visible. This means the porosities are getting better accessible. A check can be performed with the absorption of ethanol (Icon-Dry, DMG). Once the white spots disappear after application of ethanol, the enamel is ready to be infiltrated. If not, the etching procedure is repeated, with a maximum of five repetitions total.

Fig. 3: *Application of a micro-abrasive paste with a special rubber cup (Opalustre, Ultradent).*

Fig. 4: *Application of hydrochloric acid (Icon-Etch, DMG) and the isolation of neighbouring teeth with Teflon.*

Fig. 5: *Result after etching three times for two minutes.*

Fig. 6: *Application of 99 % ethanol (Icon-Dry, DMG) shows the patency to the porosities. One more etching procedure was performed after this result.*

Proximal Preparation

1. Before the start of treatment, clean the affected tooth and adjacent teeth. Remove any cleaning residue with water spray.

2. Create a sufficiently dry working field. Take appropriate measures such as rubber dam, liquid dam or similar, to protect the gingival tissue. Please follow the manufacturer's specifications and instructions

Separation

3. To ensure a successful treatment, a proximal separation of approximately 50 microns is required. Introduce one of the enclosed dental wedges into the treatment site.

▶ For better access to the proximal region, the wedge handle can be bent or detached with a twisting motion. In order to obtain sufficient separation of the teeth the wedges must be seated at an adequate depth interproximally.

▶ This should be done gradually: Insert the wedge to the point of resistance. Wait 3 to 5 s and gradually move the wedge deeper until sufficient separation is achieved.

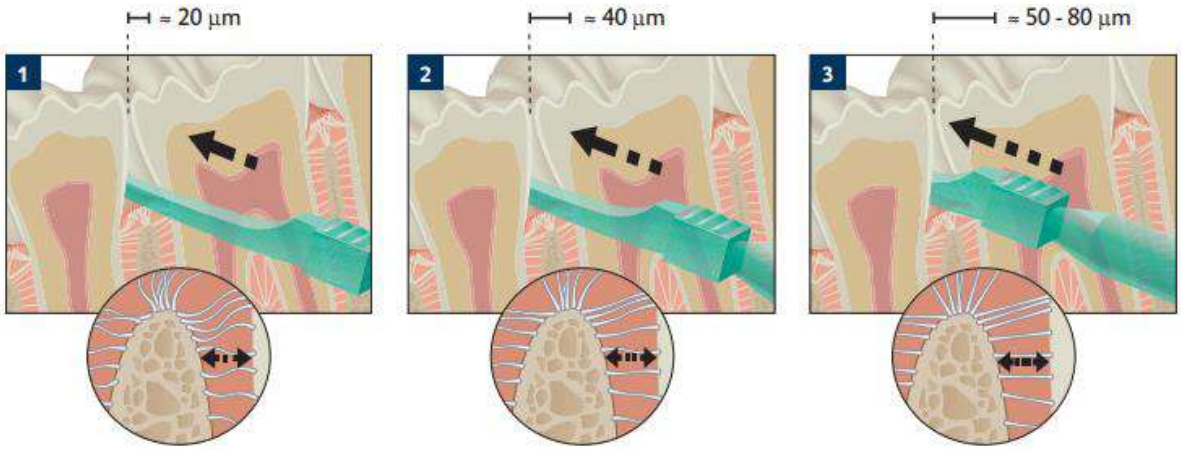
▶ Leave the wedge in the proximal space during the entire treatment procedure.

▶ Alternatively, especially in cases of tight contacts, it is possible to separate the teeth with an orthodontic separator or other separation devices

▶For temporary separation of the teeth, the specially developed separation wedges that are provided with the product are ideal. Alternatively, in exceptional cases, wooden wedges, orthodontic molar rubber rings or separators can be used.

▶Insert the separator wedges straight, slowly and with an even pressure until the first resistance. The wedge is held in this position for a few seconds and then inserted further, slowly and evenly, into the interdental space. After about 30 seconds, sufficient separation to allow treatment will be obtained.

▶In rare cases, the patient will experience discomfort during this separation process. This can be relieved by local anesthesia.



Illustrations 1 – 3 show the gradual separation of teeth (approx. 20; 40; 50 – 80 µm). The magnified areas display the gradual stretching of Sharpey's fibers. The gradual insertion of the wedge will stretch the fibers and separate the teeth.

Insert the wedge until first resistance is noticeable.

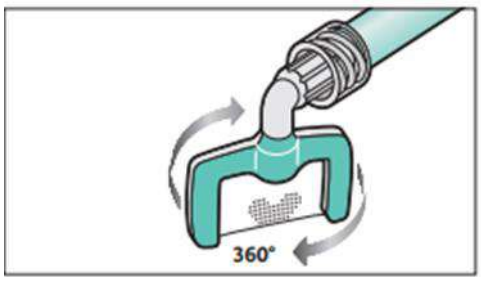
Gradually insert the wedge further…

… until sufficient separation with the wedge is achieved.

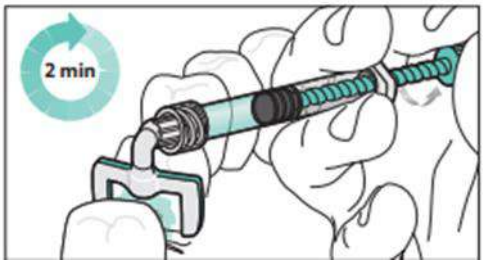
Uncovering the lesion body

For best treatment results, the hyper mineralized surface layer must be removed.

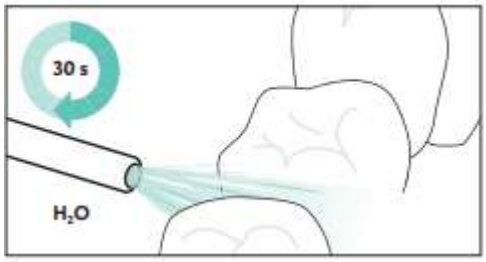
4. Screw the Proximal-Tip onto the Icon-Etch syringe and introduce the application tip into the treatment site. Be sure to align the green side of the Proximal-Tip with the area to be treated.



5. Apply an ample amount of Icon-Etch onto the lesion site (1 ½ to 2 turns of the shaft). Let Icon-Etch set for 2 minutes. The etching gel will be activated by slightly moving the applicator. Remove excess material

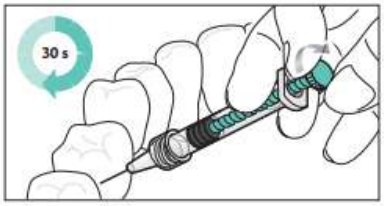


6. Remove the application tip from the proximal area. Suction off Icon-Etch and rinse with water for a minimum of 30 s. Dry thoroughly with oil-free and water-free air



Drying

Screw the application tip onto the Icon-Dry syringe, apply an ample amount of material onto the lesion and allow to sit for 30 s. Dry thoroughly with oil-free and waterfree air.



Infiltration

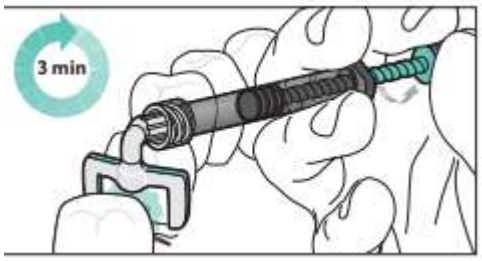
▶ Do not apply Icon-Infiltrant under direct operating light as this may cause the material to set prematurely.

8. Screw a new Proximal-Tip onto the Icon-Infiltrant syringe and introduce the application tip into the treatment site. Be sure to align the green side of the Proximal-Tip with the area to be treated.

▶ The material can only be dispensed on the green side of the Proximal-Tip.

9. Apply an ample amount of Icon-Infiltrant onto the lesion site (1 ½ to 2 turns of the shaft).

10. Let Icon-Infiltrant penetrate fully for 3 minutes. Infiltration will be enhanced by slightly moving the applicator. Add small amounts of material during the three minutes.



11. Remove the application tip from the treatment site. Remove excess material with dental floss

12. Light-cure Icon-Infiltrant from all sides for at least 40 s (total).

13. Screw a new Proximal-Tip onto the Icon-Infiltrant syringe, repeat the application, and allow to penetrate for 1 minute. Remove the application tip from the site. Remove excess material with dental floss.

14. Light-cure Icon-Infiltration from all sides for at least 40 s (total).

15. Screw a new Proximal-Tip onto the Icon-Infiltrant syringe, repeat the application, and allow to penetrate for 1 minute. Remove the application tip from the site. Remove excess material with dental floss. Then light-cure from all sides for at least 40 s (total).

16. If a second lesion needs to be treated repeat steps 1 through 13 for the affected site.

17. Remove the wedge and rubber dam. Use polishing strips for the surface finish

Place rubber dam

Place wedge for temporary tooth separation

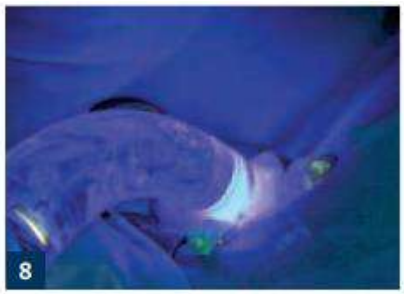
Apply Icon-Etch for 2 min

Remove Icon-Etch with water spray

Apply Icon-Dry and dry with air

Apply Icon-Infiltrant for 3 min

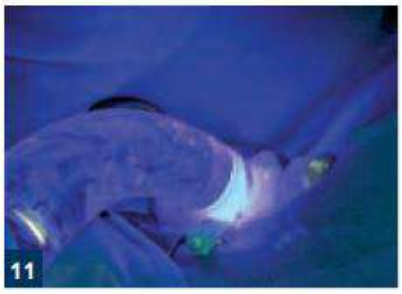
Remove excess



Light-cure for 40 sec

Reapply Icon-Infiltrant for 1 min

Remove excess



Light-cure for 40 sec

Clean the treated surface and remove excess

Smooth Surface Preparation

1. Before the start of treatment, clean the affected tooth and adjacent teeth. Remove any cleaning residue with water spray.

2. Create a sufficiently dry working field. Take appropriate measures; such as rubber dam, liquid dam or similar, to protect the gingival tissue.. Do not use rubber dams made from thermoplastic elastomers. Ensure that the treated lesion is completely accessible.

Uncovering the lesion body

For successful elimination of white spots, it is imperative that the surface layer of the lesion is completely removed in order for the Infiltrant to gain access to the lesion body. The light application of a medium grit abrasive disk can be utilized in cases of highly demineralized white spot lesions prior to etching.

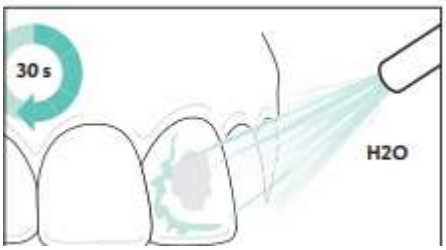
3. Screw the Smooth Surface-Tip onto the Icon-Etch syringe

4. Apply an ample amount of Icon-Etch onto the lesion site by turning the syringe shaft carefully. Periodically massage the Etch over the 2 minute period. Remove excess material with a cotton wad.

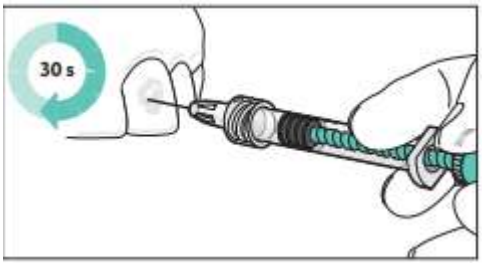
Note:

Unless white spots are treated early, i. e. 1 to 2 months after bracket removal, it is recommended to repeat the etching step up to three times

5. Suction of Icon-Etch and rinse with water for at least 30 s. Dry with oil-free and waterfree air



6. Screw the application tip onto the Icon-Dry syringe, apply an ample amount of material onto the lesion, and allow to set for 30 s.



Drying

7. After the visual inspection, dry the lesion thoroughly with oil-free and water-free air

Infiltration

8. Screw a new Smooth Surface-Tip onto the Icon-Infiltrant syringe.

▶ Do not apply Icon-Infiltrant under direct operating light as this may cause the material to set prematurely.

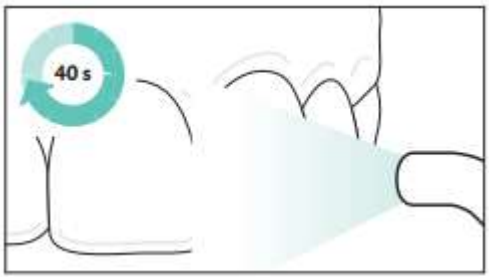
9. Apply an ample amount of Icon-Infiltrant onto the etched, dried surface by turning the shaft.

10. Allow Icon-Infiltrant to penetrate for 3 minutes adding material to keep the surface wet. The infiltration will be enhanced by slightly massaging with the applicator.

▶ In case of deeper and larger defects the esthetic result can be improved by extending the exposure time up to 6 minutes.

11. Remove excess material with a cotton wad and dental floss

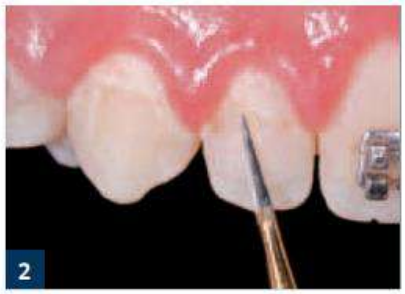
12. Light-cure Icon-Infiltrant for 40 s.



13. Screw a new Smooth Surface-Tip onto the Icon-Infiltrant syringe, repeat the application, and allow penetration for 1 minute. Remove excess material with a cotton wad and dental floss, and light-cure for a minimum of 40 s.

14. Remove the rubber dam. Use polishing cups (or similar) for the surface finish.

Initial situation



Clean surface

Polish with polishing paste

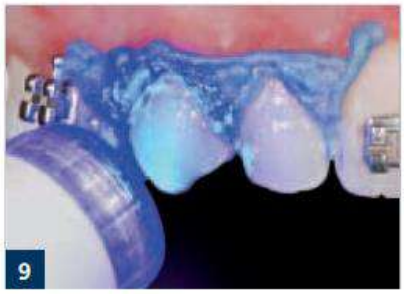
Apply isolation (rubber dam or gingival barrier)

Apply Icon-Etch for 2 min

Remove Icon-Etch

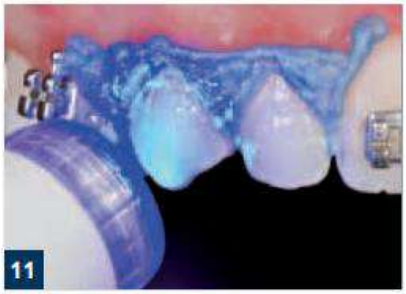
Apply Icon-Dry and dry with air

Apply Icon-Infiltrant for 3 min



Light-cure for 40 sec

Reapply Icon-Infiltrant for 1 min



Light-cure for 40 sec

Final result after polishing

Side effects

• In some cases, contact allergies with similar composite products have been reported.

• Contact of Icon-Etch with the oral mucosa causes a white surface coloration. This will subside after a few days

Reasons for failure

1- Inefficient isolation

2 -Incomplete resin polymerization;

3 -Depth of the lesion

4- Interaction Polymerization inhibiting substances such as products containing eugenol (e. g. temporary cements) must not be used in combination with this material

5- errors Technique application

6- poor oral hygiene controll

7- Problems with the manufacture of materials and defects in storage

8- position of tooth

9- Cooparetive of patiant

Resin Infiltration in Primary Teeth

The management of non-cavitated caries lesions using the resin infiltration technique in primary teeth differs from that in permanent teeth. Firstly, primary enamel is less mineralized, more porous and aprismatic when compared to permanent enamel. As a result, the diffusion coefficient seems to be greater in primary enamel. Secondly, the proximal surface layer is less mineralized and thinner in primary molars compared to the permanent ones and thus, the rate of progression of proximal caries in primary molars is significantly higher than that in the permanent ones .primary teeth exhibited better infiltrant penetration than permanent teeth, after 1 minute application of resin. On the other hand, 3–5 minutes are required to almost completely infiltrate a natural lesion in permanent teeth with a lesion extended to the inner half of enamel, whereas, one-minute application resulted in only superficial infiltration. Following 5 minute resin application, Liu et al. found no significant differences in the overall penetration between primary and permanent molar lesions but the penetration abilities of primary molars were slightly higher than those of permanent teeth in lesions confined to the outer half of enamel. conducted a split-mouth study for one year to assess the efficacy of resin infiltrated lesions covered by fluoride varnish vs fluoride varnish treatment only on the proximal lesions of deciduous molars. Lesion progression was assessed clinically and radiographically.

Proximal caries in primary molars treated by resin infiltration and fluoride varnish progressed significantly lesser (23%) than those treated with fluoride varnish only (61%) after one year .

clinical case.

Fig. 1: *Initial situation with large white spots on the incisal half of 11 and 22. Patient experienced trauma on primary incisors at the age of 4. The history, shape, location, asymmetry and absence of similar lesions on the other teeth indicate the diagnosis of post traumatic white spots. The opaquer areas of the white spots indicate deeper parts of the lesion that will require a deeper treatment.*

Fig. 2

Fig. 3

Fig. 4

Fig. 2: *Rubber dam placement after having chosen the color of the composite that will be needed after the erosion-infiltration steps.*
Fig. 3: *The depth of the lesions indicates a thicker well-mineralized surface layer that needs more than just acid erosion in order to access the body of the lesion for infiltration. To accelerate the process and reach good final result, a red ring bur is delicately used on the surface layer prior to the acid.* **Fig. 4:** *Prior to each etching step, the surface layer is sandblasted as well as the healthy enamel surrounding the white spots to optimize the result and limit the »edge effect« due to an insufficient infiltration of the margin of the lesion.*

Fig. 5

Fig. 6

Fig. 7

Fig. 5: *Icon-Etch is applied for 2 min and repeated 4 times because Icon-Dry did not give satisfied masking results of the white spots.*
Fig. 6 and 7: *After several steps alternating mechanical and chemical erosion, the use of Icon-Dry finally shows a satisfied result with a dramatical masking of the white lesions.*

Fig. 8

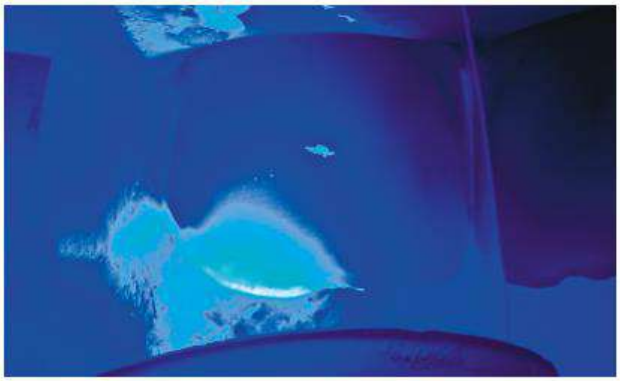


Fig. 9

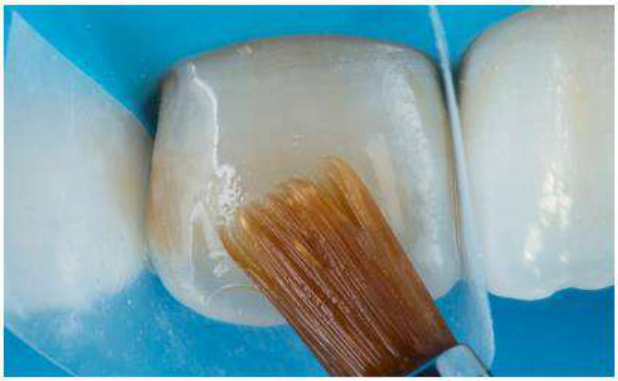


Fig. 10

Fig. 8, 9 and 10: *Apply the Icon-Infiltrant for 3 min and then light curing; followed by the application of Icon-Infiltrant for another 1 min and light curing again. To restore the morphology of the vestibular surface after the deep infiltration, a thin layer of enamel composite (Dark Enamel Essentia®, GC) is applied, light cured and polished.*

Conclusion

In order to perform a treatment that can balance the effectiveness and minimal invasive approach, a proper diagnosis of the lesion prior to any kinds of treatment is important. Depending on the etiology of the lesion we can have an idea of its shape and depth. It will help us to know if the good final outcome needs a superficial or deeper erosion-infiltration treatment. The latter will always need some composite to restore its initial morphology at the end of the treatment

Fig. 11: *Final situation one year after the treatment show an amazing stability of the infiltration result.*

Aesthetic Outcome of Resin Infiltration Therapy

Cosmetics and esthetics are current trends of dental industry. As more and more patients are demanding for minimally invasive cosmetic enhancement without anesthesia and drilling, the technique of resin infiltration may be considered as a microinvasive treatment of smooth-surface white spot lesions and also one that allows for the recovery of natural tooth appearance

clinical case.

Fig. 1-2: *Initial intra oral picture and initial polarized picture.*

Fig. 3

Fig. 4

Fig. 5

Fig. 3-5: *First step after Isolation with rubber dam placement is a prophylactic polishing. The deep cycle protocol is then : sandblasting with alumine oxyde 27 microns (Fig. 3). Erosion with Icon-Etch (15% HCl) 2 minutes (Fig. 4) Deshydratation with Icon-Dry (application of alcohol) (Fig. 5). At this step we have to control if the spot is always present. If yes, a second same cycle is necessary* [3].

Fig. 6

Fig. 7

Fig. 8

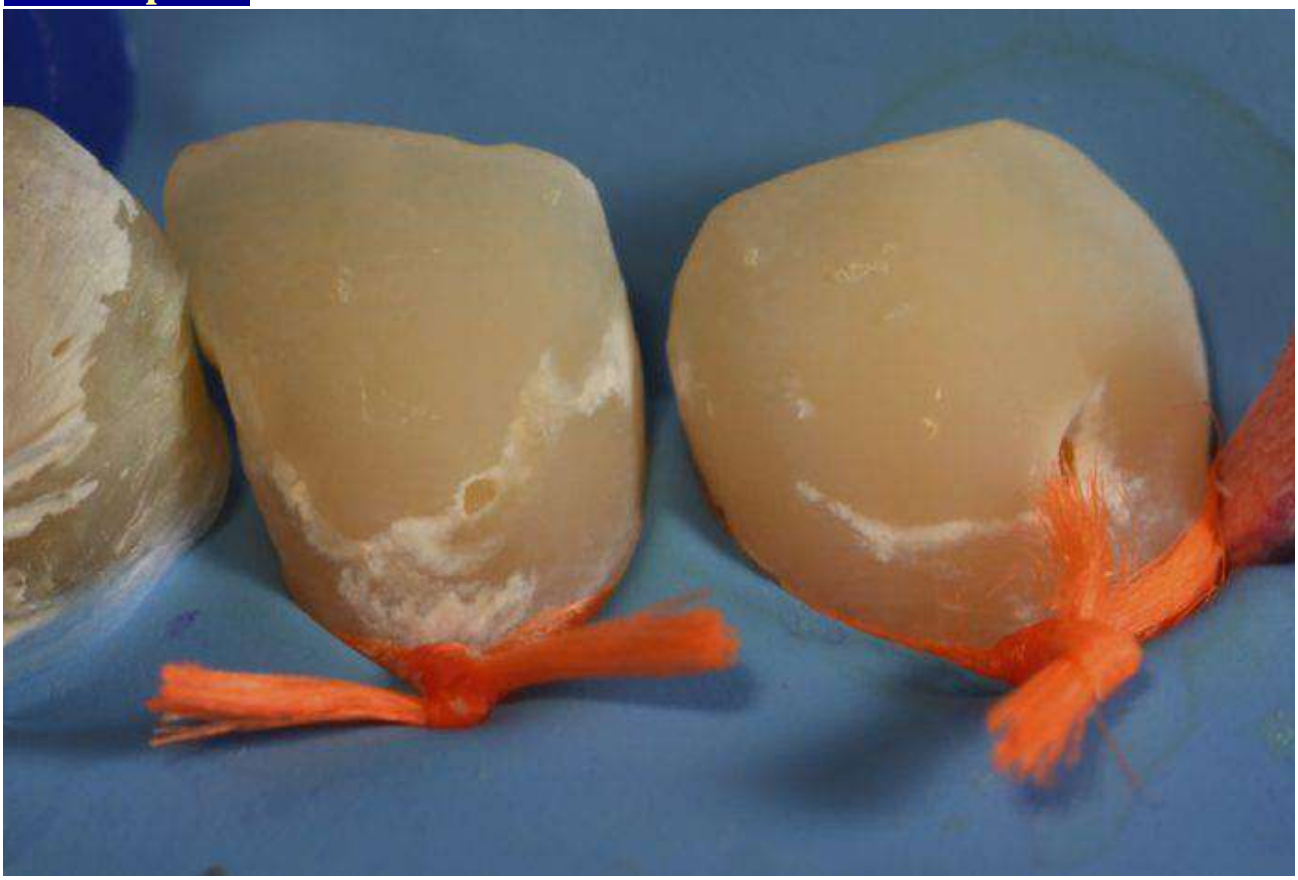
Fig. 6: *The third times Icon-Dry application (after 3 cycles). For our patient 3 deep cycles have been necessary: the optical change now concerns all lesions in totality and infiltration is possible.* **Fig. 7:** *Infiltration is performed with Icon-Infiltrant during 3minutes* [4]. *Use of dental floss before light curing is recommended. A second infiltration is necessary for 1 minute and light curing too.* **Fig. 8:** *All the lesions are translucent. If the hollow left by milling or sandblasting is significant, the slight loss of hard tissue can be made up with composite. After light-curing of the infiltrate, the resin will be used as an adhesive support. For this reason, glycerin should not be used before composite application. Several studies have shown that bonding between the resin infiltrate and composite is of very good quality* [5]. *So the application of a thin composite build-up to this tooth is performed with one single shade of enamel composite resin. No stratification is required : only a work of surface texture with different brushes. A last light curing is necessary under glycerin to avoid the inhibited layer because of oxygen.*

Fig. 9: *Final intra oral picture. After two months the result is satisfactory.The beauty of this internal dentin stratification has been conserved!*

Fig. 10: *Final polarized picture*

The histopathology of traumatic hypomineralization involves subsurface hypomineralization under a relatively wellmineralized surface layer. The surface layer is the result of post-eruptive ionic reprecipitation. It is due to inconsistent angles that the results of treatment of traumatic hypomineralization by erosion-infiltration are difficult to predict. In the case of white spots involving deep lesions of the enamel superficial infiltration is not sufficient and a new technique has been developed : the deep infiltration. A deep infiltration treatment is proposed to our patient. Before the treatment the patient is informed a composite resin will be probably use on the teeth to mask concavity and alteration of enamel. Even if it remains a very conservative treatment. The concept of deep infiltration involves paying a price in the form of mild mutilation of the enamel through preparation by sandblasting or milling so as to ensure that the infiltration can spread through almost the whole of the lesion if the latter is deep.

Case reports



Although fixed appliances treatment has become an integral part of modern orthodontics, it has also been associated with certain adverse effects. Among these white spot lesions (WSLs) are prominent, as they have a negative impact on the esthetic outcome of orthodontic treatment and might progress into carious lesions (1). The risk of development of WSLs, as a common side effect of fixed orthodontic treatment is rather high (2-4). Initially, a WSL shows an apparently intact surface layer, followed underneath by the more porous lesion body, giving a chalky opaque appearance, as light is scattered mainly within the lesion body (5-7). Scattering is caused at interfaces between substances with different refractive indices as enamel, water, and air (7). Generally, WSLs could appear as early as 1 month after bracket placement; meanwhile, the

formation of dental cavitation might require up to 6 months. WSLs are frequently perceived on the dental buccal surfaces, around the brackets, mainly in the gingival area (7-8). Caries infiltration is a new micro-invasive treatment option for such cases, where enamel porosities attributed to mineral loss during demineralization are occluded by infiltration with a low-viscosity, light-cured resin, which penetrates the entire lesion extension, mechanically stabilizes the fragile, porous enamel structure and isolates microbia from their nutritious environment (9). The benefits of the resin infiltration technique have been clinically document ed (9-11) in cases of proximal and free-surface enamel lesions, which were efficiently infiltrated instead of undergoing more invasive restorative approaches. Recently, in vitro evidence of enhanced infiltrant penetration has been corroborated by in situ (12) and short-term clinical trials (13-14) which have shown the effectiveness of resin infiltration in preventing further demineralization under cariogenic conditions.

Fig.1

A 16-year old male patient complained the aesthetics of his smile being affected by white and yellowish lesions. The lesions were observed after removing fixed appliances at the end of a 3 year orthodontic treatment. The parents' main concern was to stop lesion progression with a minimally invasive treatment. Contrary to remineralization using fluoride or CPP–ACP, infiltrant resin can improve the color, even in deeper lesions, because it penetrates. Moreover, the result appears instantly after treatment(15,16). In addition, resin infiltration is much less invasive than microabrasion or composite restorations (15)

Fig.2

For maximum protection of the patient during the infiltration procedure, rubber dam and floss ligatures were applied. Infiltration in the upper jaw was performed in two different appointments due to patient co-operation concerns.

Fig.3

The tooth surface was cleaned with a rubber cup and prophylaxis paste

Fig.4

The surface layer was eroded by the application of 15% hydrochloric acid gel (ICON - Etch; DMG, Hamburg, Germany) for 120 seconds to expose the body of the lesions. The procedure was repeated three times. Acid rinsed off for at least 30 seconds with water spray and dried.

Fig.5

The lesions were desiccated using ethanol (ICON-Dry; DMG) for 30 sec followed by air-drying.

Fig.6

An infiltrant resin (ICON-Infiltrant; DMG) was applied to the surface and allowed to penetrate inside for 3 min. Excess material was wiped away using a cotton roll from the surface, and using dental floss in the proximal spaces before light curing.
After light curing for 40 seconds, the application of infiltrant resin was repeated once for 3 minutes, and light cured for 40 sec.The reason for applying the resin twice is because of the shrinkage of materials after the first application resulting in the generation of space that can then be occluded by a second application (15). Final view of infiltrated lesions.

Fig.7
While all teeth have experienced enamel loss to varying extent, 11(mesial), 21 (mesial and distal) and 22 (mesial) need to be restored with resin composite.

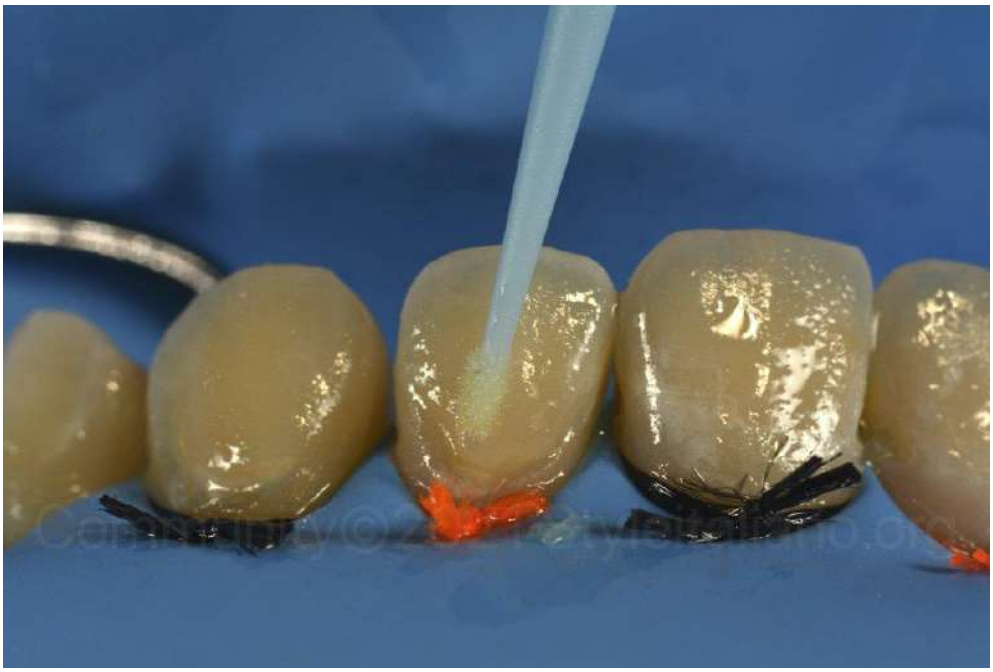


Fig.8
After bonding procedures, a thin layer of enamel composite, the Enamel shade (SiE White Dental Beauty) was placed. The whole procedure was performed under microscope in order to be precise and to keep material addition to a minimum, only where it was necessary to reproduce the right anatomical contour

Fig.9
The White Dental Beauty CompoSite system only features one enamel shade, with mimetic characteristics and significantly simplifies the whole procedure. Thanks to its calibrated translucency and opalescence, it is ideal to simply mimic enamel properties.

Fig.10
Clinical image after application of the final enamel layer 11 and 21, before finishing

Fig.11
Clinical image after application of the final enamel layer 21(distal) and 22 (distal), before finishing

Fig.12
Immediately after rough finishing, polishing and removal of rubber dam

Fig.13
Immediate postoperative view under cross-polarization (polar_eyes Cross polarization filter).

Fig.14
Next appointment involved the same procedure for 12 and 13. Under strict isolation, application of hydrochloric acid (ICON-etch) for 2 minutes, rinsed off for 30 seconds and repeated 3 times.

Fig.15
After rinsing and drying with compressed air, we proceeded with the application of ethanol (ICON-Dry) for 30 seconds and inspected thoroughly.

Fig.16
Final step was the application of the infiltration resin (ICON infiltrant). Then, light curing for 40 seconds and reapplication of the resin infiltrant. Clinical image of 13 and 12 with the final view of the infiltrated lesions. Obviously infiltration masked yellow and brown areas, so we can be less invasive in the second approach.
Labial surface of 13 and mesial surface of 12 need to be restored with resin composite to result in an acceptable anatomical contour.

Fig.17
After bonding procedures, placement of a thin layer of enamel composite, the Enamel shade (SiE White Dental Beauty) on the labial surface of 13 and mesial surface of 12.

Fig.18
Immediately after finishing, polishing and removal of the rubber dam.

Fig.19
Immediate postoperative view under cross-polarization (polar_eyes Cross polarization filter).

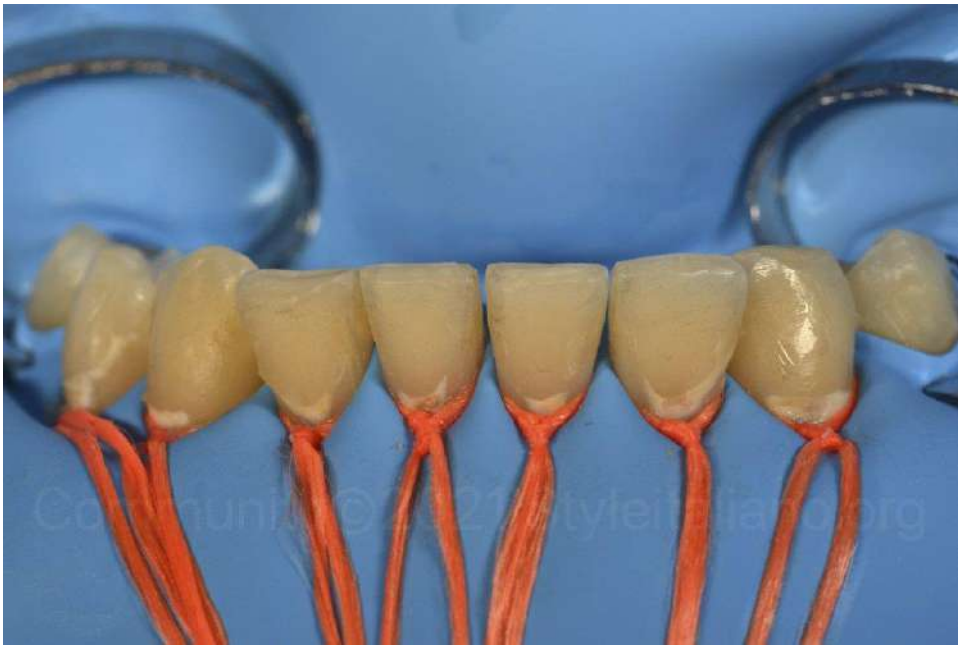


Fig.20
Third appointment involved the lower teeth. The main difficulty was the location of the white spot lesions, very close to the gums. To manage this we used strict isolation and ligatures which were pulled during the procedure.

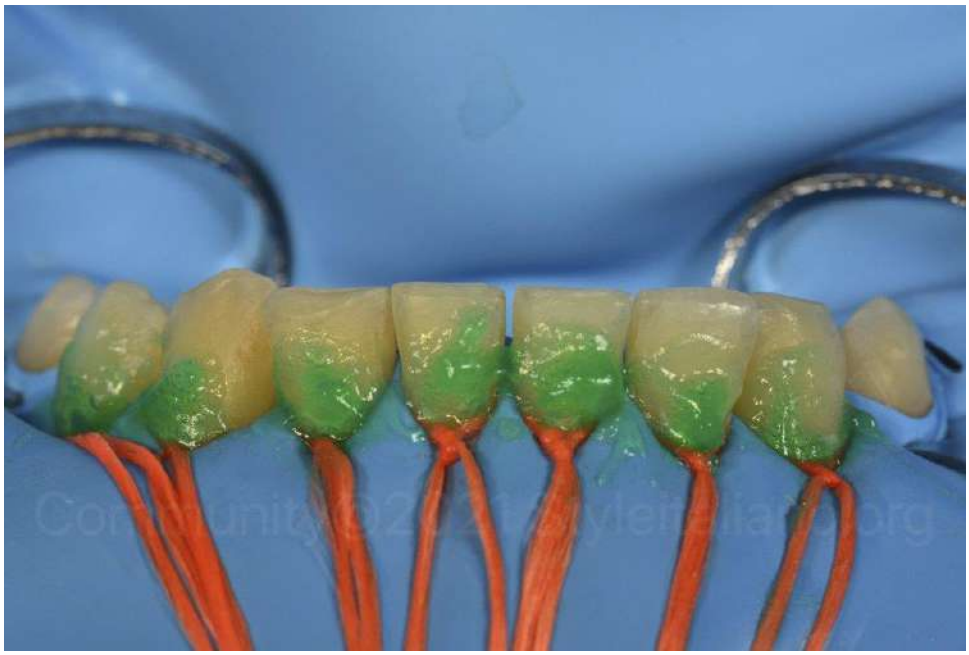


Fig.21
Application of 15% hydro-chloric acid gel (ICON -Etch; DMG, Hamburg, Germany) for 120 seconds to expose body of the lesion. The procedure was repeated three times.

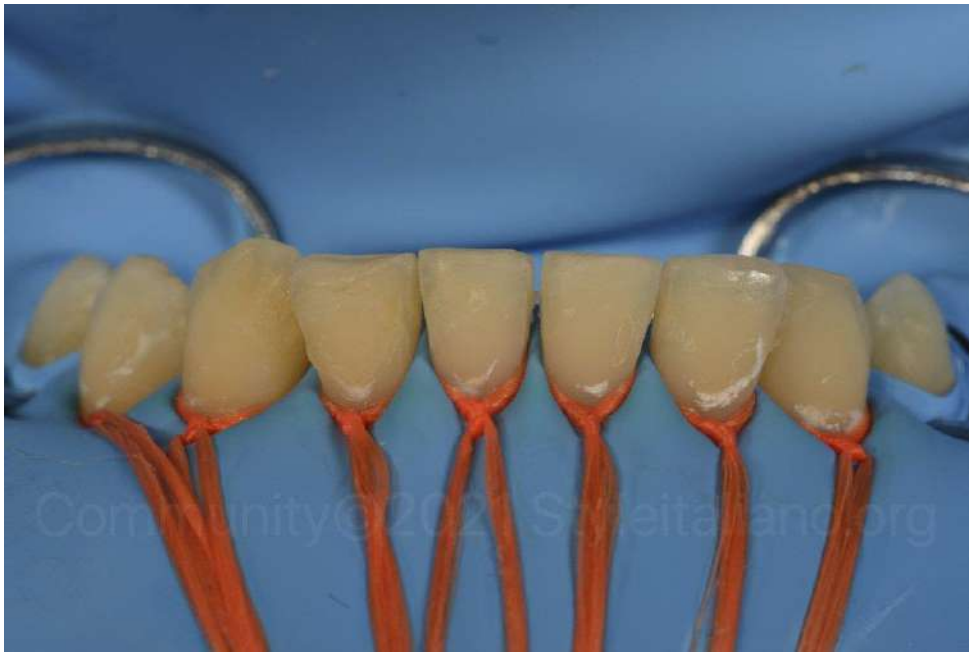


Fig.22
Acid rinsed off for at least 30 seconds with water spray and dried. Follow with application of ethanol (ICON -Dry; DMG) for 30 sec and air drying. Clinical image immediately after thoroughly drying teeth with compressed air.

Fig.23
Final step was the application of the infiltration resin (ICON infiltrant). Remove excess and floss. Then, light curing for 40 seconds. Clinical image after repeating the procedure.

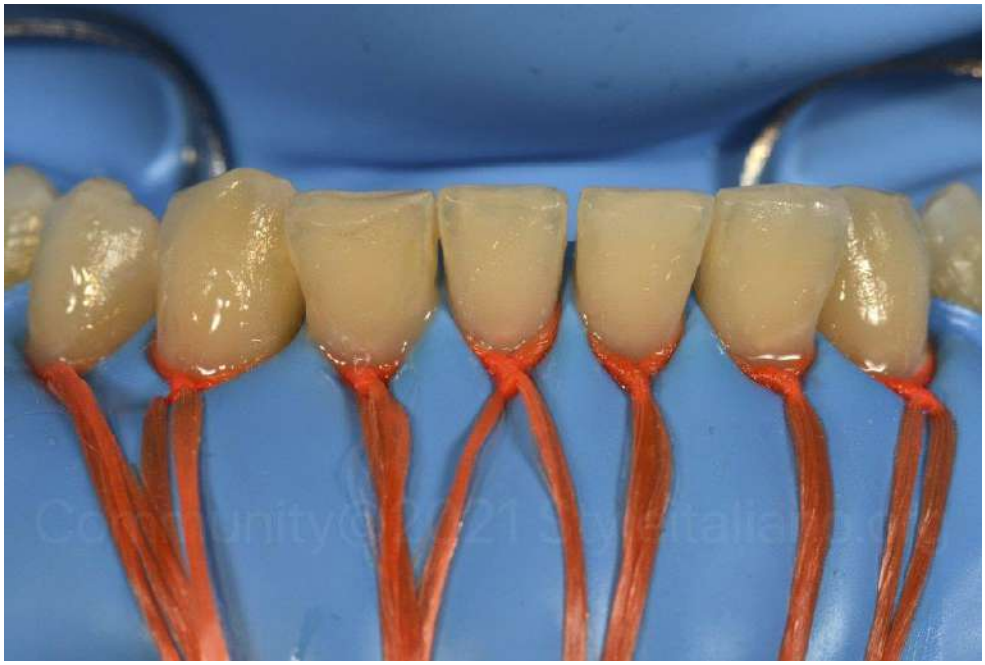


Fig.24
A small amount of flowable resin was placed under the microscope, only at the lesions where the enamel loss was more extended.

Fig.25
Immediately after finishing, polishing and removal of rubber dam.

Fig.26
Immediate postoperative view under cross-polarization (polar_eyes Cross polarization filter).

Fig.27
Two-week postoperative view of the upper teeth and polarized view.

Fig.28
Two-week postoperative view of the lower teeth and polarized view.

Fig.29
View of teeth at two-week recall. The outcome is highly acceptable for a no-prep approach and minimally invasive for a young patient. Micro-invasive treatment of post orthodontic white spot lesions, in this case was completed, without any mechanical removal of tooth structure.

Conclusions

Manifestation of white spot lesions after bracket removal is a common side effect due to the poor oral hygiene adjacent to fixed appliances . In contrast with other treatments, infiltration technique with ICON offers a micro-invasive tool without any drilling or tooth substance removal.Moreover, it can stop progression of the lesions and make resin-embedded enamel more resistant to future acid attack .
In cavitated lesions, infiltration treatment can be combined with composite application in one step for better results, in parts of the lesion where loss of tooth substance occurs .Use of microscope was a valuable parameter because gave us the opportunity to estimate accurately the topography of each lesion and manage the resin application exactly in the parts where resin infiltration was inadequate to restore enamel loss. The satisfactory clinical result has made it possible to avoid more invasive treatments.

Discussion

White spot lesions are detected frequently and can be problematic for the patients with much esthetic concern. Several techniques have been proposed to improve the appearance of these white spot lesions. Among these, remineralization can be considered first for correct these white spot lesions. Because reminer- alization is a natural phenomenon resulting in the partial reversal of what is an early caries lesion. According to Willmote who studied the effect of fluo- ride and saliva after removal of fixed orthodontic appliance, the difference in percentage reduction of the white spot lesion size showed a reduction in lesion area of about a third after 12 week and a half after 26 weeks.8 However, remineralization of white spots takes a long time, and the lesions may be left to some degree. And it can inhibit the mineralization of subsurface lesions.

On the other hand, Ogaard et al. warned against treating visible white lesions on labial surfaces with concentrated fluoride agents, since this

arrests the lesion (hypermineralization) and prevent complete repair.5 Especially deep lesions tend to remineralize only superficially. Consequently, arrested lesions show thick and highly mineralized surface layers.9 The underlying lesion body is still porous, however, and thus the whitish appearance often persists.10 Moreover, during remineralization stains can be incorporated into the lesion, leading to the formation of brown spots, a situation that might be judged as even more unesthetic.9 Therefore, some authors advocated allowing slow and gradual remineralization by saliva or low-concentrated fluoride agents such as fluoride mouth rinse and fluoride containing tooth- paste on shallow lesion (< 60 μm), as this results in greater repair and less visible lesion. Enamel microabrasion was designed to improve the surface texture, remove the stains and recover remineralization. It removes superficial parts of the lesion by abrasion with a slurry of hydrochloric acid and pumice, and the enamel surface becomes smooth and glossy.10 Both chemical erosion with hydrochloric acid and mechanical abrasion with pumice simultaneously take place. Consequently, it uniformly removes up to 0.2 mm of enamel surface. According to Murphy et al. the mean reduction in white spot lesion size was 83%.Microabrasion can be applied for white spot lesion, fluorosis, demineralizarion after orthodontic treatment, localized hypoplasia, idiopath- ic hypoplasia. Donly et al. found that microabrasion recreated the outer, prism-free region and teeth becameglassyandnamed‘abrosioneffect’. This layer reflects or scatters the light and masks mild imperfections. However, substantial amounts of enamel often unfortunately have to be eroded to improve appearance with this technique. Resin infiltration technique is an alternative thera- peutic approach to prevent further progression of enamel lesions. This treatment aims to occlude the microporosities within the lesion body by infiltration with low-viscosity light-curing resins that have been optimized for rapid penetration into the porous enamel. The resin penetrates into the lesion body, driven by capillary forces. This technique aims to create a diffusion barrier inside the lesion, not on the lesion surface. Robinson et al. reported that about 60 ± 10% of the lesion’s pore volume had been occu- pied by

resin.15 According to Kielbassa et al., resin infiltrates into subsurface lesions and produces resin- infiltrated parts of the lesion.16 And the depth of resin infiltration was over 100 μm. A positive side effect of resin infiltration is that enamel lesions lose their whitish appearance when their microporosities are filled with the resin and look similar to sound enamel. The principle of masking enamel lesions by resin infiltration is based on changes in light scattering within the lesions. Sound enamel has a refractive index (RI) of. The microporosities of enamel caries lesions are filled with either a watery medium (RI 1.33) or air (RI 1.0). 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

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