

# Icon smooth surface

## Case Reports

A series of case reports showing clinical challenges and their treatment solutions with Icon smooth surface.





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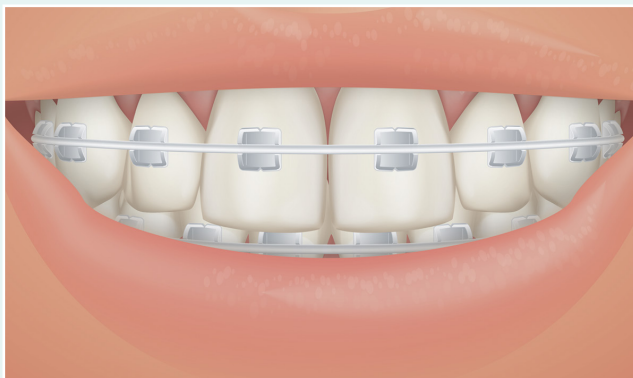


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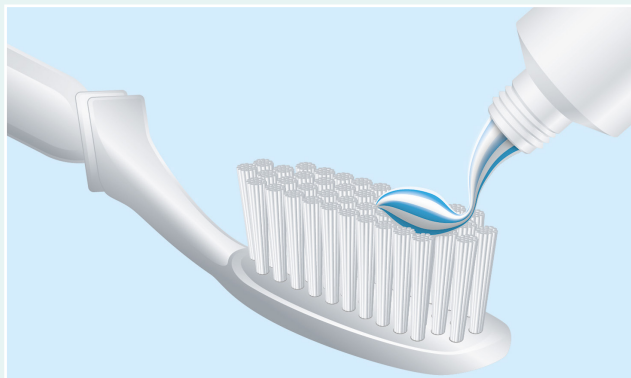
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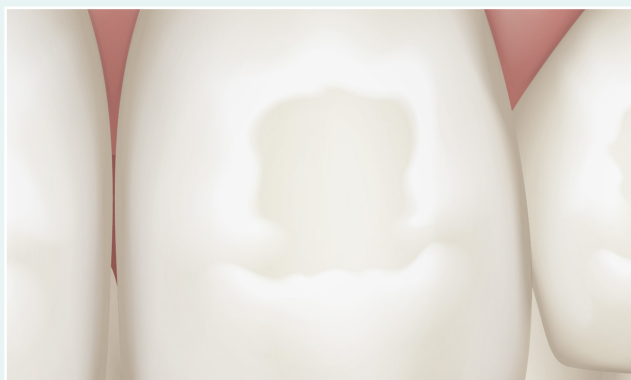
**Patient history or etiology.** Orthodontic treatment with fixed brackets.



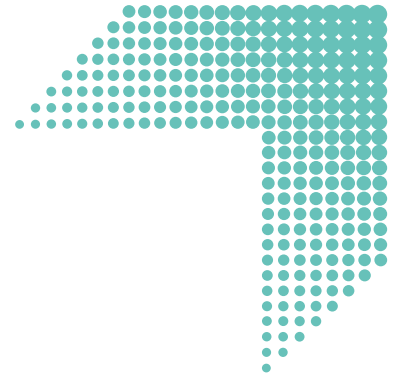
**Affected tooth/teeth.** One or more teeth depending on the oral hygiene.



**Localization.** Typical around brackets. Mostly cervical.



**Border.** Well-demarcated.



## Cariogenic white spot lesions.

Dental history and visual diagnosis.

**D**ental caries is one of the most prevalent diseases in the world and by far the most prevalent disease of the oral cavity. It is caused by the metabolic activity of the oral biofilm, which is triggered by the frequent intake of fermentable carbohydrates such as sugars. Characteristic for caries is a loss of minerals of the affected dental hard tissues. In younger patients, caries mostly starts in the dental enamel. The early and medium stages of the disease are characterized by an increased porosity of the affected enamel, which clinically appears as a white chalky spot due to increased light scattering between the crystals and the pores. In later stages the porous enamel breaks down and forms characteristic cavities.

Dental caries is a dynamic disease in which phases of mineral loss and mineral gain alternate. If mineral loss outbalances mineral gain, the disease progresses and the lesions are called »active«. If, however mineral gain predominates, lesions may arrest. Mineral gain is usually confined to the outermost 30-200 µm in the so-called surface layer of the lesion, whereas the lesion body remains porous. Therefore, even arrested lesions still look opaque and often are hard to discriminate from active lesions.

Caries lesions only form in tooth surfaces where dental plaque is allowed to grow for longer periods, the so-called predilection sites. As most of these sites are hidden, initial caries usually is not an esthetic problem. However, during treatment with orthodontic brackets caries lesions may also form in buccal free smooth surfaces. After debonding of brackets, these lesions usually can be arrested quite easily by brushing and fluoride application. However, the unaesthetic appearance of the whitish spots often persists or even gets worse due to inclusion of food stains in the surface layer, which makes the lesions look brownish.

Caries infiltration originally was developed to arrest non-cavitated caries lesions. One positive side-effect of the treatment is that the whitish color of enamel lesions disappears during and after infiltration as the infiltrated resin reduces the light scattering between the enamel crystals. In this way lesions can be camouflaged and an esthetic improvement can be achieved quite easily with only minimal substance loss.

*Prof. Dr. Sebastian Paris*



# Camouflage of a fluorotic change in the enamel with superimposed post-orthodontic decalcifications.

Prof. Dr. Michael Knösel



Fig. 1



Fig. 2



Fig. 3

Fig.1-3: Initial situation: Enamel fluorosis with superimposed post-orthodontic decalcifications.

A 16 year-old patient presented with a request for visual improvement of the anterior esthetics impaired by irregularly distributed whitish enamel spots. A treatment performed elsewhere with fixed orthodontic devices (multi-bracket (MB) devices) was completed roughly one year before; in the course of this treatment four premolars were removed and the gaps closed. The subsequent retention of the final result was performed with fixed retainers in the upper and lower jaws, which were in situ at the time of presentation. In a visual and tactile examination the whitish opaque spots were diagnosed, because of their striated appearance without sharply defined edges, as fluorotic change in the enamel, visible in a varied

distribution on all present teeth, and, in the case of the premolars in particular, very clearly including the occlusal surfaces. Furthermore, under closer examination and after drying, it was possible to identify a border around the area that was previously covered by the bracket bases of the MB device, in particular on the maxillary canines and lateral and central incisors. Moreover, striated changes could also be seen underneath the former bracket bases. The suspicion that the patient has an enamel fluorosis with superimposed post-orthodontic decalcifications is consistent with the information provided by the patient in relation to a worsening of the spotting during the MB treatment.



Fig. 4: Use of a hand-made micro-abrasive slurry of roughly 15% HCl/pumice powder (acid-pumice technique) with a polishing cup at low rotational speed.



Fig. 5: Application of Icon-Etch for two minutes.



Fig. 6: Drying with Icon-Dry.



Fig. 7: Result after etching with Icon-Etch five times.

The patient had previously found information on potential forms of treatment on the Internet and volunteered a strong desire for infiltration treatment to improve the dentofacial esthetics.

Together with the patient, the scope of the treatment was determined: treatment of the changes in enamel in the esthetically relevant areas of teeth 15-25 (with teeth 014/024 missing) and 33-43. For successful treatment of pronounced fluorotic enamel changes and also deep WSL, the literature describes micro-abrasive slurries comprising roughly 15% HCl/pumice powder (acid-pumice technique) [1-4].

Because using an infiltration technique exclusively was deemed difficult given the initial situation (enamel fluorosis with superimposed post-orthodontic decalcifications, and some micro-cracked enamel structures as on tooth 12), it was decided to proceed with a combined method to improve the result of the fluorosis infiltration:

The HCl acid gel contained in the infiltration kit and pumice powder (Ernst Hinrichs Dental, Goslar) were used to prepare a slurry to selectively pre-treat areas with deep fluorotic changes. This was done by carefully working on the affected teeth 15-25 and 33-43 with a polishing cup and the slurry at a low rotational speed.

After the slurry was rinsed away, the infiltration treatment followed, with the HCl gel applied to the affected enamel areas and left for two minutes in each case.

Applying a rubber dam, in particular in the area of the lower incisors, often prevents conditioning and infiltration of the areas near the gingiva; this measure was therefore deliberately avoided.

After the gel was rinsed away, drying was performed in each case with the ethanol contained in the kit. Drying with ethanol is vital for achieving the capillary effect required for infiltration; it also makes it possible to assess the esthetic result that can be expected.

This assessment was performed together with the patient; in this case, the HCl steps were repeated five times to prepare the enamel surfaces sufficiently to achieve the desired esthetic result.

This was followed by infiltration; the infiltrant was left for three minutes and subsequently light-polymerized. A second infiltrant application was performed, which is recommended with a reaction time of one minute to compensate for the composite polymerization shrinkage, followed by further light-curing and polishing of the infiltrated enamel areas.

After infiltration, a significant masking was apparent, deemed highly satisfactory by the patient, of both the fluorotic enamel areas and the enamel areas decalcified by the orthodontic treatment.





↗ Fig. 8



↗ Fig. 9



↗ Fig. 10

Fig: 8-10: Significant masking after infiltration, deemed highly satisfactory by the patient, of both the fluorotic enamel areas and the enamel areas decalcified by the orthodontic treatment.

### Key Learnings

- ↗ Icon infiltration treatment can get satisfactory esthetic results on the patients suffering from both post-orthodontic decalcifications and fluorosis.
- ↗ In order to remove the well mineralized enamel surface layer, Icon-Etch gel can be combined with microabrasion pumice and can even be used for more than three times.
- ↗ Icon-Dry can predict the esthetic result after Icon-Infiltrant. This assessment should be performed together with the patient.

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# Masking White Spot Lesions with Icon.

Dr. Ingo Frank



Fig.1: Initial situation before treatment with Icon.

White spot lesions are early signs of demineralization under an apparently intact enamel surface layer. These early enamel lesions show a whitish appearance as a result of an increased porosity within the lesion due to mineral loss [1].

In case of poor oral hygiene or salivary hypofunction even on buccal surfaces of the teeth a plaque accumulation can result in white spot lesions [2]. Especially in patients that underwent orthodontic treatment with brackets white spot lesions can occur due to the difficulties to clean the area adjacent to the bracket. Several clinical studies show a high prevalence of white spot lesions after bracket removal [3, 4].

With preventive strategies like improvement of the oral hygiene and topical fluoride application there is a good chance of arresting early lesions. Though the caries progression may be stopped the whitish appearance often remains as the remineralization is superficial and there is still a porous lesion body underneath [2]. In addition to that stains can be incorporated into the lesion with the result of a brownish appearance of the lesion (brown spots) which often leads to even more esthetic deficiencies. That is why the dentist may become confronted with the patients desire to rehabilitate esthetics. Treating non-cavitated white spot lesions may include tooth

bleaching, micro-abrasion, composite fillings or even prosthetic restorations like veneers or combinations of these treatments [5]. All these options are quite invasive implying tooth structure loss. As a micro-invasive alternative caries infiltration (Icon) can be applied to prevent further caries progression. It imbeds the adjunctive effect of masking the whitish appearance of the lesions.

With the infiltrant the porosities in the lesion body are occluded. Therefore, this treatment may be used not only to arrest enamel lesions but also to improve the esthetic appearance of buccal white spots.

## Clinical case report

A 19 year-old male patient complained about the appearance of his upper front teeth due to whitish lesions on the vestibular surfaces. He had an orthodontic treatment with brackets during adolescence and when the brackets were removed the white spot lesions became apparent.

In order to fulfill the patient's desire of an esthetic improvement we suggested an Icon treatment to mask the lesions.



Fig. 2



Fig. 3

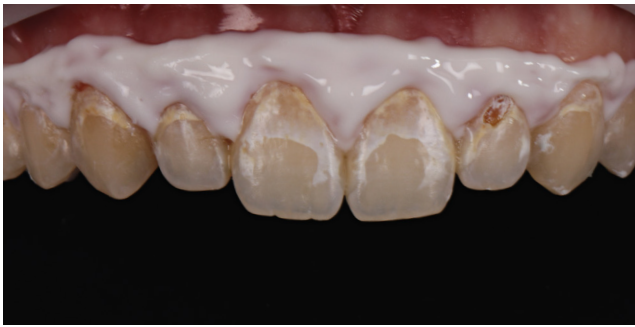


Fig. 4

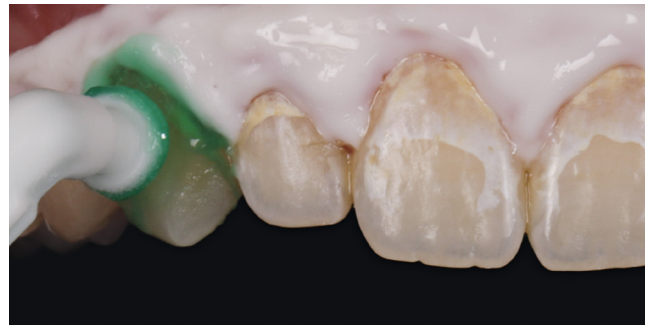


Fig. 5



Fig. 6

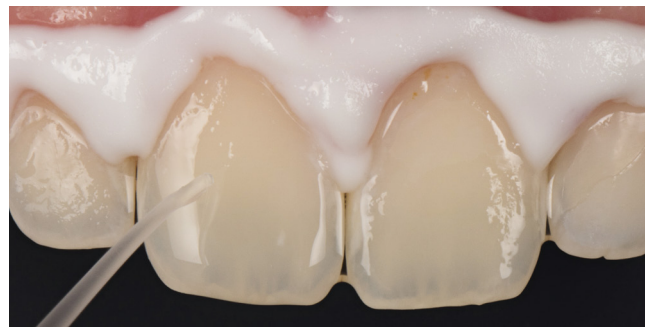


Fig. 7



Fig. 8



Fig. 9

Fig. 2: In order to get an accessible isolated working field optragate was applied. Fig. 3: Professional cleaning of the vestibular surfaces with fluoride free prophylaxis paste. Fig. 4: For the application of Icon an optimal dry working field is mandatory. Furthermore any contact of the material with the gingiva should be avoided. In this case the liquid dam was applied. Fig. 5: Application of the Icon-Etch for 2 minutes to condition the lesion surface. Fig. 6: The etching gel is covering all white spot lesions of the vestibular surface of the teeth 13-23. The cavitated lesion on the vestibular surface of tooth 22 has been treated with a composite filling. After 2 minutes the etching gel is removed with water spray for 30 seconds and the surface is dried. Fig. 7: When Icon-Dry is applied, the lesions disappear for the

wetting moment. This gives the operator a preview of the results. If the whitish-opaque coloration on the etched enamel diminishes, the procedure can be continued with the infiltrant application. If the lesions are still visible, the etching step should be repeated. After 30 seconds the surfaces are thoroughly dried with oil free and water-free air. Fig. 8: Application of the infiltrant. Fig. 9: After the infiltrant has been applied on all treated surfaces, the infiltrant is set for 3 minutes. Excess material is removed with a cotton wad and dental floss before it is light cured for 40s. This infiltrant step is repeated letting the infiltrant set again for 1 minute before excess removal and light curing. Finally the surfaces are polished.





➤ **Fig. 10:** Final result after Icon treatment.

The white spot lesions are masked and a highly satisfying result with large improvement of the esthetic appearance could be achieved.

### Discussion

The manifestation of white spot lesions after bracket removal is a common side effect due to the impeded oral hygiene adjacent to the bracket during orthodontic treatment [3, 4, 6]. As esthetic demands of the patients arise dentists do not only have to take care of preventing a further progression of the lesions but also have to deal with the patient's wishes of masking these lesions which can be esthetic compromising. In contrast to other treatment options like composite filling, micro-abrasion or bleaching, Icon offers a micro-invasive treatment tool without drilling that can not only stop the lesions progressions but also can mask the whitish appearance of the white spot lesions. In case of adjacent cavitated lesions Icon can be successfully combined with a conventional filling in this area. When the cavitated lesion is restricted to enamel the infiltrant even enhances the shear bond strength of the adhesive [7]. Filling procedure and infiltration can be combined in one step. When the cavitation involves dentin the filling should be performed before the Icon treatment as the hydrochloric acid of the Icon-Etch might lead to a decrease of shear bond strength of the adhesive to dentin [8].

### Conclusion

With Icon white spot lesions can be masked effectively. It is micro-invasive to the treated enamel surfaces, prevents further demineralization and is easy in handling and application. In case of white spot lesions occurring next to cavitated lesions Icon can successfully be combined with a conventional filling of the cavitated lesion.

### Key Learnings

- Infiltration treatment can be combined with direct composite restoration when both white spots and cavitated caries lesion exist on enamel.
- When the cavitated lesion is restricted to enamel the infiltrant even enhances the shear bond strength of the adhesive.  
Filling procedure and infiltration can be combined in one step.
- When the cavitation involves dentin, the filling should be performed before the Icon treatment as the hydrochloric acid of the Icon-Etch might lead to a decrease of shear bond strength of the adhesive to dentin.

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# Masking and arresting of caries during treatment with brackets.

Prof. Dr. Hendrik Meyer-Lückel, Dr. Richard Johannes Wierichs, Fidaa Shikh Ali



Fig. 1: Situation before treatment.

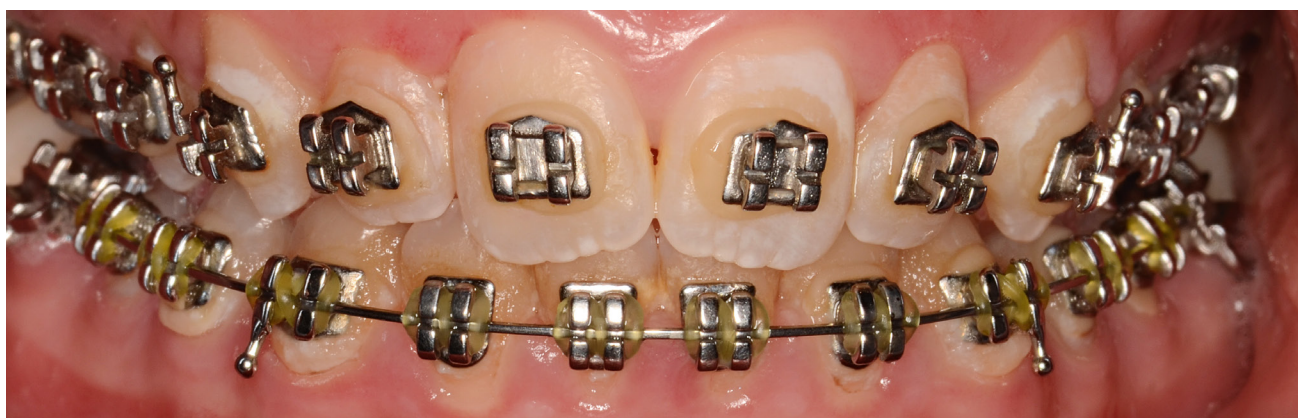


Fig. 2: One week after treatment.

## Introduction

White spot lesions (WSL) are non-cavitated caries lesions that are often observed in the esthetical visible area [2,7]. During orthodontic treatment with fixed elements (brackets) plaque retention is increased resulting in a higher risk for new WSL [16]. In a study on premolars being referred for extraction it could be shown that the development of WSL occurs within 4 weeks under fixed, but non-cemented orthodontic bands [12]. Due to the design of orthodontic appliances biofilm is frequently not sufficiently removed by oral hygiene measures. It is, thus, no surprise that after orthodontic treatment a WSL prevalence between 11 % [18] and 97 % [1] and a WSL incidence between 7 % [17] and 73 % [15] has been reported. The varying values can be explained by, firstly, different examination methods and, secondly, by the use of different thresholds to detect WSL.

To prevent caries lesions during orthodontic treatment an optimal oral hygiene is crucial [16]. However, if WSL are detected after an orthodontic treatment it seems to be related to the type of lesion whether a complete remineralization can be achieved [12]. On the one hand, slightly visible, initial WSL often completely remineralize in saliva, since fixed elements – increasing the plaque retention – have been removed. The remineralizing effect can be increased by the additional use of fluoride e.g. in form of fluoride varnish [12,17]. On the other hand, clearly visible, severe WSL cannot be visually masked by saliva and fluoride alone. They remain visible for life. Thus, for severe WSL more invasive treatments are indicated. During orthodontic treatment rapid debonding may be required unless oral hygiene and fluoride regimens are followed accurately [12] whereas after orthodontic treatment the appearance of the WSL should be masked.



Fig. 3: Directly after removal of the brackets.



Fig. 4: One week after removal of the brackets and after infiltration of the control teeth.

Caries infiltration is one method to mask initial non-cavitated lesions. By infiltrating the lesion microporosities of the carious enamel are obturated. Thus, the caries progression is arrested. Furthermore, due to the similar refractive index of the infiltrant (RI of infiltrant 1.52) compared with apatite (RI=1.62), light scattering is reduced and visual color differences to enamel are decreased directly after application. Thus, the visual appearance of the lesion is changed positively and the WSL appears less white than before; in other word: the lesion is masked [10, 14].

In several studies on WSL - being diagnosed after orthodontic treatment with fixed elements - a positive masking effect after the infiltration was observed [3, 4, 5, 6, 8, 9]. Furthermore, the masking effect was classified as satisfactory (although not complete) in further studies [4, 5, 8, 11]. Interestingly, the time between debonding and infiltration seems to play an important role in order to allow an effective masking of WSL [9]. The shorter the time after debonding the better the masking effect. This observation was supported in a second non-controlled study [13]. In this study the masking effect of caries infiltration was examined during the treatment with fixed orthodontic elements. Immediately after the detection of a WSL the bracket was removed, the WSL was infiltrated and the bracket was rebonded. During the subsequent 10-month follow-up 92.5 % of the infiltrated WSL showed no further worsening.

On the basis of the previous studies the success of the masking effect seems to depend on the time between detection of the WSL, debonding and infiltration. Shorter time periods between

debonding and infiltration seem to mask WSL more effectively. This raises the question if the esthetic outcome can be optimized by infiltrating WSL during the orthodontic treatment. Moreover, infiltration during orthodontic treatment arrests the lesion progress at an earlier point in time.

### Case report

A 15-year-old female patient complained of white spots in the esthetical visible area. The lesions were observed after a 24-month orthodontic treatment with fixed elements. The patient's main concern was to stop lesion progression with a minimal-invasive treatment without interrupting the orthodontic treatment. The patient was in good general health. ICDAS criteria were used for the visual-tactile assessment of the WSL [11]. Furthermore, photo documentation was performed to assess the severity of the lesions [19]. The clinical examination revealed an ICDAS level of 2 for six teeth, two of these being active lesions. The patient was asked to participate in a monocentric, controlled, randomized split-mouth study. After informed consent teeth with WSL were randomly divided into two groups. Without removing the brackets, teeth in the control group (teeth 13, 21, 23) were treated with a fluoride varnish (Tiefenfluorid®, Humanchemie, Alfeld/Leine) and those in the test group (teeth 12, 11, 22) were infiltrated with a low-viscosity polymer (Icon-Infiltrant, DMG, Hamburg) and subsequently fluoridated in the same way as the control group.



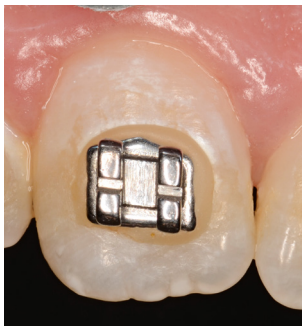


Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12

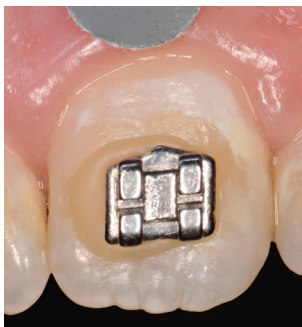


Fig. 13



Fig. 14



Fig. 15



Fig. 16

Tiefenfluorid® was applied on all teeth as followed:

- Application of the primary application solution (1 min per tooth)
- Application of the secondary application solution (1 min per tooth)

The infiltration was performed as followed:

- a. Etching the teeth with Icon-Etch (15% HCl gel for 2 min)
- b. Removing Icon-Etch and Rinsing by using the multifunction syringe (30 s per tooth)
- c. Drying the teeth by using the multifunction syringe (30 s per tooth)
- d. Application of Icon-Dry (30 s per tooth)
- e. Drying the teeth by using the multifunction syringe (10 s per tooth)
- f. Application of Icon-Infiltrant (3 min per tooth)
- g. Removing excess material with a foam pellet
- h. Light-curing (40 s per tooth)
- i. Application of Icon-Infiltrant (1 min per tooth)
- j. Removing excess material with a foam pellet
- k. Light-curing (40 s per tooth)
- l. Polishing (dark orange and light orange Soflex disc or pink and gray rubber polisher) and Occlubrush

The steps (a-e) were repeated up to three times – if necessary – until a satisfactory esthetic result was achieved. Afterwards Tiefenfluorid® was applied as described above.

The ICDAS score was evaluated at various points in time: before treatment (baseline), one day after the treatment (d1), one week after the treatment (d7), directly after removal of the brackets (removal) – the control teeth were infiltrated during this appointment – and one week after infiltration of the control teeth (r7) (Figs. 1-4). In the present case report the time between baseline and removal was roughly two months. In the actual study, a minimum time interval of at least six months is planned to allow a more precise assessment of the control group.

For colorimetric analysis the CIE L\*a\*b\* values were measured using Photoshop CS 6 (Adobe, USA). Color differences between carious and healthy enamel ( $\Delta E$ ) were then calculated [19].

At baseline no significant difference in ICDAS-values (average  $\pm$  standard deviation) and the  $\Delta E$ -values (mean  $\Delta E$ : 18.68; SD:5.26) between the control and test group were observed. One day after (d1) and one week after (d7) the treatment a significant reduction in the  $\Delta E$ -values could be observed in the test group (Figs. 5-10), whereas no significant change could be observed in the control



group (Figs. 11-16). One week after the treatment (d7), the WSL were masked more completely than one day after infiltration (d1). Two of the three teeth in the test group (11,12) showed a reduction in the ICDAS level from 2 to 1 one day after (d1) as well as one week (d7) after treatment. Contrastingly, no change in the ICDAS level could be observed in the control group. In both groups the colorimetric analysis correlated with the clinical outcome.

## Conclusion

The visual appearance of WSL were improved by caries infiltration. The patient reported no significant adverse event after infiltration.

➤ **Fig. 1:** Situation before treatment.

➤ **Fig. 2:** Situation one week after treatment.

➤ **Fig. 3:** Situation directly after debonding.

➤ **Fig. 4:** Situation one week after debonding and infiltration of the teeth in the control group.

➤ **Fig. 5, 7, 9:** Test teeth 11, 12, 22 before treatment.

➤ **Fig. 6, 8, 10:** Test teeth 11, 12, 22 one week after treatment.

➤ **Fig. 11, 13, 15:** Control teeth 13, 21, 23 before treatment.

➤ **Fig. 12, 14, 16:** Control teeth 13, 21, 23 one week after treatment.

## Key Learnings

➤ Shorter time periods between debonding and infiltration seem to mask WSL more effectively.

➤ Infiltration can be performed during orthodontic treatment and can arrest lesion progression at an earlier point in time.

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# Resin Infiltration of (Icon DMG) Post Orthodontic White Spot Lesions.

Dr. Carla Cohn



Fig. 1



Fig. 2



Fig. 3



Fig. 4

Post-orthodontic decalcifications or »white spot lesions« are a significant aesthetic challenge. They have been reported at incidences as high as 73 % - 95 % [1, 2]. The prevalence of white spot lesions is so high due to several factors. Oral hygiene for patients with orthodontic appliances, bands and brackets is a challenge. Besides maneuvering around and cleaning between orthodontic hardware, it provides an increase in surface area for plaque and biofilm to accumulate. Add to this a teenaged patient, the most common recipient of orthodontic treatment, who may present with a lack of motivation to maintain oral hygiene and a high caries risk scenario ensues. White spot lesions can develop in as little as one month [3, 4, 5]. The lesions are often detected after debonding. Patients, parents, orthodontists and general dentists all have the same perception; that the appearance of white spot lesions is highly undesirable [6]. Studies show that resin infiltration (Icon DMG) proves to be most effective at masking white spot lesions [7] and more resistant to formation of new white spot lesions when compared to treatment with therapeutic fluoride solutions [8]. Furthermore the colour stability of caries infiltrated

teeth is durable [9, 10]. Case studies have been reported with excellent outcomes [11, 12]. In instances in which white spot lesions are treated during active orthodontic therapy, the question of bond strength to treated surfaces must be raised. It has been shown that resin infiltration of demineralized enamel does not affect the bond strength of orthodontic brackets [13].

## Case Study

Post orthodontic white spot lesions treated with resin infiltration (Icon DMG).

Fig. 1: Pre-operative photograph.

Fig. 2: Dry field is essential for success. Rubber dam is placed to isolate the field and should be inverted, or ideally ligated, to prevent leakage or saliva contamination.

Fig. 3: Prophylaxis with non-fluoridated pumice is completed; teeth are rinsed, then dried. Icon-Etch (hydrochloric acid) is applied, extrude the Icon-Etch by twisting the syringe. Etch should extend approximately 2 mm around the edges of the lesion and be placed



Fig. 5



Fig. 6



Fig. 7



Fig. 8

for 2 minutes. Once in place the etch gel should be agitated with an instrument as it will buffer shortly after contact with the surface of the tooth. Etching process was repeated a second time for this case. For long standing white spot lesions the Icon-Etch step may be repeated.

**Fig. 4:** Rinse for 30 seconds and dry completely with oil free air. Application of Icon-Dry (99% ethanol) to the dried surface. Icon-Dry can indicate the final result after infiltration. Since the result was satisfactory, the ethanol was let on the surface for 30s to promote a thorough desiccation of the enamel, followed by air-drying.

**Fig. 5:** Application of Icon-Infiltrant by twisting the syringe. At this point remove direct overhead light source to avoid premature curing of the infiltrant. Continue »feeding« infiltrant to lesion for 3 minutes.

**Fig. 6:** Remove any excess material and light cure. Repeat the infiltration process with a new vestibular tip for 1 minute. Remove excess again and light cure. Final polish with Shofu OneGloss.

**Fig. 7:** Immediate post-operative photo.

**Fig. 8:** Recall post-operative photo (two months).

## Conclusion

Micro-invasive treatment of post orthodontic white spot lesions can be completed in approximately 15 minutes chair time per tooth without mechanical removal of tooth structure or use of local anaesthetic. Excellent immediate post-operative results followed by long lasting beauty and stability.

## Key Learnings

- Recognize the aetiology and prevalence of post orthodontic decalcification/white spot lesions.
- Understand the success and effectiveness treatment of post orthodontic decalcification/white spot lesions with resin infiltration.
- Follow the clinical procedure of micro-invasive resin infiltration of smooth surface lesions.

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**Patient history or etiology.** Ingestion of excessive fluoride during enamel formation.



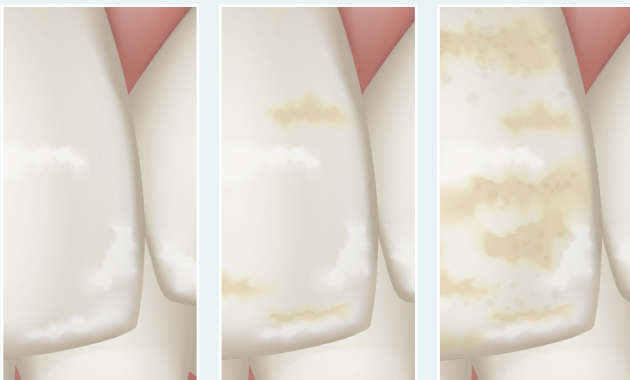
**Affected tooth/teeth.** A varying number of teeth. Bilateral, symmetrical developmental enamel opacities.



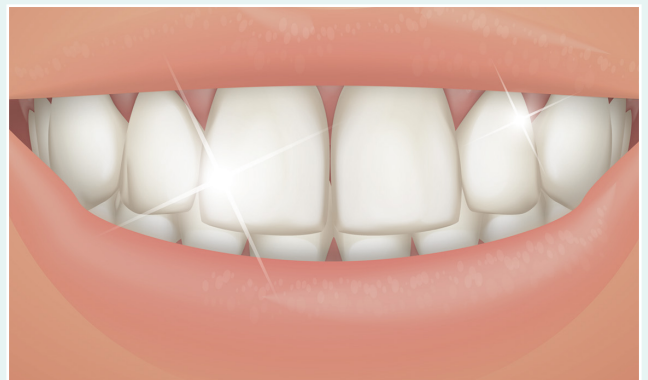
**Localization.** Whole enamel surfaces can be affected, depending on the severity.



**Border.** Irregular, distinct or diffuse opacities.

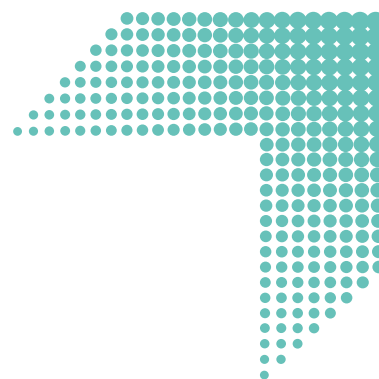


**Color.** From tiny white specks or streaks to dark brown stains and rough, pitted enamel, depending on the severity.



**Other unaffected teeth.** Smooth and glossy. They should also be a pale creamy white.





# Fluorosis

## - mild, moderate or severe.

Dental history and visual diagnosis.

**F**luoride has an important and determinant role in dental caries prevention. However, excess and constant exposure to this chemical element during enamel formation may result in fluorosis, and its severity is directly related to the amount of fluoride which the patient contacted during enamel formation/maturation. [1,3]

Clinically, mild dental fluorosis is characterized by a diffuse whitish opaque appearance caused by a porous/hypomineralized subsurface enamel with an intact surface layer. In cases in which higher concentrations or prolonged fluoride exposure occurred, moderate and more severe fluorosis present a clinical aspect ranging from more extensive and opaque whitish or brownish stained enamel to pitted enamel lesions that occur pre- or post-eruptively due to deeper defects in enamel formation/mineralization. [1,6]

Of all permanent teeth, the anterior teeth are more likely to be affected by fluorosis, since the period of development and maturation of these teeth coincides with the beginning of exposure to fluoride during the second and third year of life. [1,3]

The alteration in esthetic perception caused by fluorosis, according to its severity, can generate frustration, embarrassment and

concern when smiling, as well as potential impact in quality of life of adults and children. [4,6] More recently, resin infiltration has emerged as a viable alternative for esthetic treatment of lesions classified as mild to moderate. [2,5,7]

In milder fluorosis, the shallower subsurface porosities are usually adequately infiltrated and the esthetic results commonly pleasant. In moderate or severe fluorosis, an initial mechanical wear of the surface of the affected enamel might be required before resin infiltration, that is followed by increments of composite resins, as illustrated in some clinical cases presented in this book.

*Prof. Dr. Leandro Augusto Hilgert*

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# Effective and predictable masking of mild to moderate fluorosis with in-office bleaching prior to resin infiltration.

PD. Dr. Michael Wicht, Christoph Schoppmeier



Fig.1: Base status. Case 1.



Fig.2: Base status. Case 2.

The prevalence of dental fluorosis varies significantly among different countries depending on the level of water fluoridation and the use of fluoridated products in patients' early childhood. In Germany the prevalence is estimated around 10-15 % [3] with most of the alterations being mild to moderate expressed as whitish opacities either localised or widely spread over the enamel surface.

Recently, no strong evidence regarding the masking effect of whitish discoloration with resin infiltration was reported in a systematic review disregarding the origin of the alteration [2]. However, case reports [1, 7] and excellent clinical results achieved in our dental school support the theory that resin infiltration is a treatment alternative to direct and indirect composite or ceramic restorations. In-office or home bleaching with hydrogen or carbamide peroxide has also been reported to improve the overall aesthetic appearance of very mild and mild fluorosis yielding a more homogeneous colour [6]. Other approaches comprise micro-abrasion and the use of sodium hypochlorite in particular in discoloured teeth [4].

According to Perdigao [5] the combination of both, at home bleaching and subsequent resin infiltration led to impeccable clinical results in masking enamel fluorosis discolorations.

Based on positive results mostly published in case reports we hypothesised that in-office bleaching prior to resin infiltration improves the quantifiable and self-assessed aesthetic effect in mild to moderate dental fluorosis. 26 patients were included in a RCT. The test group received an in-office light enhanced power bleaching with 25 % hydrogen peroxide (Zoom, Philips, NL); the control group was pre-treated accordingly using an ACP gel (Relief Oral Care Gel, Philips, NL) instead of the active substance. After two weeks both groups were infiltrated (Icon, DMG, Germany). Digital images were taken at every appointment and after 1, 3 and 6 months respectively. Based on calibrated images Delta E-values between health enamel surface and fluorosis Spots were calculated. Additionally patients' were asked as to how they judge their overall appearance on a VAS (1-10).



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8

Statistical analyses (mixed linear model) revealed that resin infiltration alone leads to a significant masking of discoloured enamel opacities most likely connected with dental fluorosis. In office bleaching with 25 % H<sub>2</sub>O<sub>2</sub> following Icon infiltration treatment significantly improves Delta E values and the self estimated appearance after 6 months. The following two clinical cases visualise the treatment protocol and clinical results up to 6 months follow-up.

### Cases

Two female patients (24 and 27 yrs.) exhibiting mild (case 1) and moderate (case 2) dental fluorosis particularly on their upper front teeth. Both patients applied for inclusion in the above-mentioned clinical trial and were proven to meet the inclusion criteria.

**Fig. 3:** Close up case one 21-23. Marked opacities in the incisal region become more pronounced after desiccation.

**Fig. 4:** In-office bleaching (case one). Patients were prepared for in-office bleaching using the Zoom kit (Philips, NL). Liquid dam is thoroughly applied along the gingival margin in both, the bleaching and infiltration procedure. Every patient in the test group received 3 cycles of light enhanced power bleaching each cycle lasting for 15 minutes.

**Fig. 5 and 6: Bleaching results.** After bleaching teeth are obviously brighter in both cases. Patients preferred that bleached look, however Delta E-values do not decrease significantly. These patient-centered findings are not in line with our personal observations. It appears that not only the sound but also the fluorotic enamel appears brighter after bleaching leading to an overall lighter appearance than the baseline status.

**Fig. 7:** Close up case one 21-23. After bleaching the teeth appear brighter including the discoloured areas. The contrast is not levelled out but rather more pronounced most probably enhanced by desiccation directly after treatment.

**Fig. 8:** Case 1 before infiltration. After in-office bleaching we waited for 2 weeks before the infiltration procedure. After rehydration the teeth appear more uniform yet brighter in colour. The treatment protocol intended application of hydrochloric acid for 6 minutes (three rounds, 2 minutes each) and 10 minutes of infiltration and one additional minute after the initial infiltrating procedure. The prolonged etching and infiltration increases the probability to sufficiently remove the intact surface layer and allows the infiltrant to homogeneously fill up deeper porosities. Apart from these modifications the infiltration process was performed as recommended by the manufacturer.





Fig. 9



Fig. 10



Fig. 11



Fig. 12

#### Fig. 9 and 10: Results immediately after infiltration.

In both cases the masking was almost complete with a more or less homogeneous colour. As a side effect teeth may tend to appear yellowish directly after treatment. On the one hand this phenomenon is ascribed to the photo initiator camphor quinone used in the product on the other hand white opacities that gave the affected teeth a whiter look will obviously and intentionally disappear. It is advisable to inform patients about this likely effect beforehand. We observed a tendency towards remission of this effect during the observation period.

#### Fig. 11 and 12: Highly satisfied patients with almost complete masking of the fluorotic enamel.

In general, patients in both groups appreciated the infiltration as a non to micro-invasive treatment option. The combination of in-office bleaching and infiltration at a later time led to superior results regarding Delta-E and self-estimated VAS values. Interestingly, both outcomes correlate significantly indicating that objectively measured parameters are in line with a patient-centred outcome.

#### Key Learnings

- Patients who feel impaired by mild to moderate fluorosis have many treatment options to choose from. With direct composite restorations or veneers on the rather invasive and the latter definitely on the costlier side, resin infiltration is comparably little invasive and less expensive.
- Infiltrating fluorotic teeth is a predictable and efficient treatment option, however prolonged hydrochloric etching and infiltration time may be advantageous.
- Bleaching combined with infiltration significantly enhances the masking effect as indicated by the improved Delta-E values and patients' satisfaction.

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# Icon resin infiltration.

Gabriela Caldeira Andrade Americano, Prof. Dr. Vera Mendes Soviero



**Fig. 1-2:** Through a clinical exam, it was diagnosed that all of permanent anterior teeth, which were erupted, had fluorosis. However, the teeth 11 and 21 were more severely affected according to Thylstrup and Fejerskov index [12].

## Abstract

Aesthetic problems due to Fluorosis can occur in children and adolescents. The aim was to describe a case report about the use of infiltrant resin to mask diffuse opacities. A male patient aged 12 years attended the Paediatric Dentistry clinic of the Rio de Janeiro State University, Rio de Janeiro, Brazil. Through a clinical exam, it was diagnosed that incisors had fluorosis. The teeth 12, 11, 21 and 22 were treated with infiltrant resin (Icon, DMG, Hamburg, Germany). All procedures were done in accordance with manufacturer instructions. Furthermore, Icon-Etch and Icon-Dry were applied three times in order to enhance the masking of the defects. The immediate result as well as 1 week and 4 months after the treatment were satisfactory. The use of infiltrant resin (Icon) can mask diffuse opacities improving the esthetics without a significant loss of tooth tissue.

## Introduction

Aesthetic problems due to enamel developmental defects can occur in children and adolescents. Fluorosis is a defect of enamel mineralization, characterized by porosity of the enamel subsurface [1]. Clinically, fluorosis can be seen as slight accentuation of the perikymata, diffused opacities with a opaque white appearance or chalky white enamel with some yellow to brown staining and pitting [2]. There are several treatment options for aesthetic problems due to fluorosis, such as bleaching, microabrasion and restorative techniques. Bleaching therapy has been reported by being able to mask the blemishes and providing a more uniform appearance [3,4]. Microabrasion works well for shallow defects, but it can result in some reduction of enamel [5, 6.] Treatment with resin composites can correct or improve enamel imperfections [7], however this

procedure also ends up in a loss of tooth tissue. Infiltrant resin has masked white spot lesions [8, 9], because this resin has a refractive index similar to apatite crystals. Thereby, light refraction and, consequently, the colour differences of enamel are reduced [10]. As the fluorotic enamel is porous [11], the same as the white spot lesions, the resin infiltration can be a good alternative to mask the opacities. Thus, this paper aimed to describe a case report about the use of infiltrant resin (Icon, DMG, Hamburg, Germany) to mask diffuse opacities in permanent anterior teeth.

## Case Report

The patient male, 12 years old, has been assisted at the Paediatric Dentistry clinic of the Rio de Janeiro State University, Rio de Janeiro, Brazil.



**Fig. 3:** Before the treatment with Icon, the teeth 12, 11, 21 and 22 were cleaned and a rubber dam was placed.



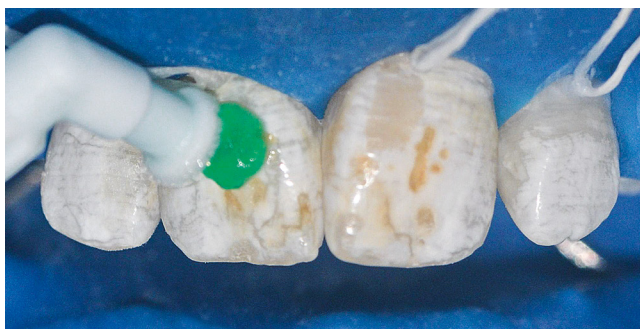


Fig. 4

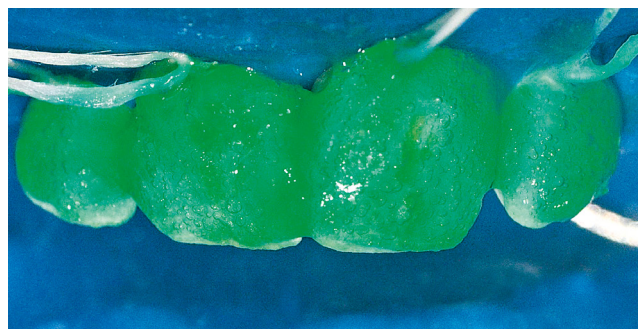


Fig. 5



Fig. 6



Fig. 7

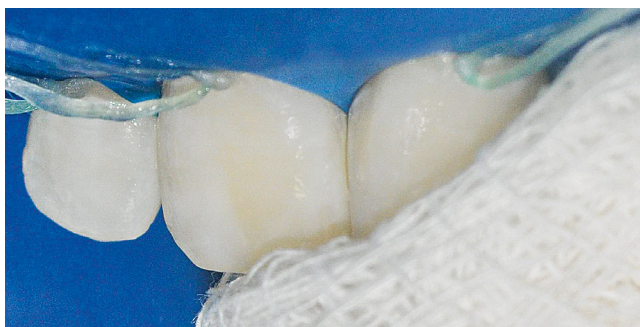


Fig. 8



Fig. 9

Fig. 4-5: Icon-Etch was applied on the buccal surfaces of the upper incisors for 2 minutes. Fig. 6: Once the teeth were rinsed for 30 seconds and air-dried, Icon-Dry was used for 30 seconds. After the first acid-etching, part of the white diffuse opacities seemed masked when Icon-Dry was applied, but not the yellowish ones. Fig. 7: A second application of Icon-Etch was done for 2 minutes, followed by dry air and Icon-Dry. However, the yellowish opacities were still visible. Hence, a third application of Icon-Etch was done for 2 minutes. This time a gentle friction was done using Icon-Etch applicator on the yellowish areas. Finally, the yellowish opacities seemed masked when they were wetted by Icon-Dry. Fig. 8: All the surfaces were dried again, and Icon-Infiltrant was applied. The excess material was removed with gauzes. Fig. 9: First the infiltrant set for 3 minutes and then light-curing each tooth for 40 seconds.

## Discussion

Whenever an aesthetic procedure is recommended, it should be based on patient's demand. Aesthetic perception is very much subjective and individual. An enamel defect can be an aesthetic problem for dentists, but not for patients. Furthermore, it can be argued that girls may be more concerned with their appearance than boys [6]. In the present case, the patient was a boy and felt really upset about the appearance of his teeth. Thus, the decision to treat the upper incisors aesthetically came from the patient's wish to have non-discolored teeth. Thereby, as the infiltrant resin has masked white spot lesions [8, 9], it was decided to use the Icon to mask the diffuse opacities. The colour difference of enamel between white spot lesions and sound enamel occurs because the refractive indices of enamel, water and air are different [9]. If lesion pores are filled with water or air, in other words, if lesions are wet or dried, they will appear opaque, because the refractive indices of water and air

are smaller than the enamel refractive index. When pores are filled with infiltrant resin, lesions are masked because the refractive indices of sound enamel and infiltrant are similar [9, 13]. As fluorotic enamel has a porous subsurface in the enamel below a well-mineralized surface [11] similar to white spot lesions, the infiltrant can behave in the same way as in white spot lesions.

Diffuse opacities were well masked by the infiltrant in this clinical case. The application of Icon-Etch for three times was necessary to achieve a complete erosion of the surface layer allowing the infiltrant to penetrate as it happens in caries lesions [8, 14]. Compliance with manufacturer instructions on how to use the material may have contributed for the treatment success, for instance, the polishing of tooth surfaces. The polishing of treated areas enhances the colour stability of the masking probably due to reduction of the roughness. Clinical conditions, such as type of opacity and infiltration depth,



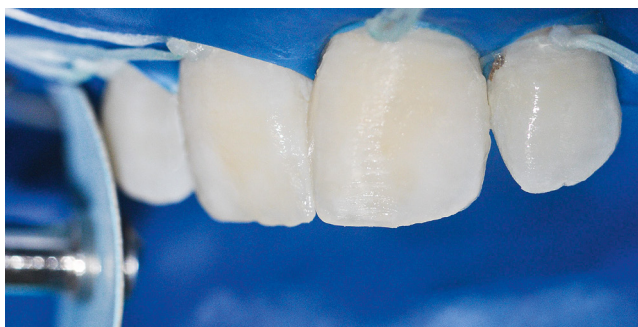


Fig. 10

Fig. 10: According to manufacturer instructions, the application of Icon-Infiltrant was repeated for 1 minute. To finalize the treatment, the tooth surfaces were polished with composite resin polishing discs.



Fig. 11: The final aspects one week after the treatment.



Fig. 12: Follow-up of 4 months. The guardians signed an informed consent form regarding all the procedures.

complete or incomplete infiltration, polymerization shrinkage as well as resin colour, can also interfere in the final result [10]. In this case, the rubber dam hampered Icon to set in the gingival margin. Nonetheless, even with slight blemishes in the gingival margin of the upper incisors, the patient was very satisfied with the treatment. Icon-Infiltrant has a lot advantages over other treatment techniques. The infiltrant can mask deeper lesions [9] without a significant loss of tooth tissue, which the microabrasion [5, 6] and restorations with resin composites are not able to do. Moreover, a resin layer is not necessary, once the material penetrates into the enamel [9]. The removal of the excess material with gauzes also retains the surface shape [15]. In contrast to the bleaching therapy, which can reduce the microhardness of demineralized enamel surfaces [16], the infiltrant resin can strengthen the enamel structure mechanically [17].

## Conclusion

The use of Icon-Infiltrant can mask diffuse opacities improving the esthetics without a significant loss of tooth tissue.

## Key Learnings

- Fig The polishing of treated areas enhances the colour stability of the masking probably due to reduction of the roughness.
- Fig In contrast to the bleaching therapy, which can reduce the microhardness of demineralized enamel surfaces [16], the infiltrant resin can strengthen the enamel structure mechanically [17].
- Fig The use of infiltrant resin (Icon) can mask diffuse opacities improving the esthetics without a significant loss of tooth tissue.

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