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Case Reports

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Dental 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. Caries is characterised by 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 characterised 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 diseases 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 is not usually an aesthetic problem. However, during treatment with orthodontic brackets, caries lesions may also form in buccal free smooth surfaces. After debonding of brackets, these lesions can usually 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 was originally developed to arrest non-cavitated caries lesions. One positive side effect of the treatment is that the whitish colour 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 aesthetic improvement can be achieved quite easily with only minimal substance loss.

Prof. Sebastian Paris

Case 1. 1

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

Prof. 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 aesthetics 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 microabrasive 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 expressed a strong desire for infiltration treatment to improve the dentofacial aesthetics.

Together with the patient, the scope of the treatment was determined: treatment of the changes in enamel in the aesthetically relevant areas of teeth 15–25 (with teeth 14/24 missing) and 33–43. For successful treatment of pronounced fluorotic enamel changes and also deep WSL, the literature describes microabrasive 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 aesthetic 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 aesthetic result.

This was followed by infiltration; the infiltrant was left for three minutes and subsequently light-polymerised. A second infiltrant application was performed, which is recommended with a reaction time of one minute to compensate for the composite polymerisation 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 achieve satisfactory aesthetic results on patients suffering from both post-orthodontic decalcifications and fluorosis.
- In order to remove the well mineralised 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 aesthetic 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 demineralisation 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]. In patients thathave undergone orthodontic treatment with brackets, white spot lesions are particularly likely occur due to the difficulties in cleaning 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 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 remineralisation is superficial and there is still a porous lesion body underneath [2]. In addition, stains can be incorporated into the lesion resulting in a brownish appearance of the lesion (brown spots), which often leads to even more aesthetic deficiencies. As a result, the dentist may be confronted with the patients' desire to rehabilitate the aesthetics. Treating non-cavitated white spot lesions may include tooth bleaching, microabrasion, composite fillings or even prosthetic restorations like veneers, or combinations of these treatments [5]. All these options are quite invasive and imply tooth structure loss. As a microinvasive alternative, caries infiltration (Icon) can be applied to prevent further caries progression. It embeds 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 aesthetic 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 fulfil the patient's desire for an aesthetic 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 achieve 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 covers 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 while the wetting is in progress. This gives the operator a preview of the results. If the whitish-opaque colouration 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 40 s. This infiltrant step is repeated, with the infiltrant allowed to 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 aesthetic 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 aesthetic 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 aesthetic compromising. In contrast to other treatment options like composite filling, microabrasion or bleaching, Icon offers a microinvasive treatment tool without drilling that can not only stop the lesions' progression 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 actually enhances the shear bond strength of the adhesive [7]. Filling procedure and infiltration can be combined in one step. When the cavitation involves dentine, the filling should be performed before the Icon treatment as the hydrochloric acid of the Icon Etch could lead to a decrease in the adhesive's shear bond strength to the dentine [8].

Conclusion

With Icon, white spot lesions can be masked effectively. It is microinvasive to the treated enamel surfaces, prevents further demineralisation 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 are present on enamel.
- When the cavitated lesion is restricted to enamel, the infiltrant actually enhances the shear bond strength of the adhesive. Filling procedure and infiltration can be combined in one step.
- When the cavitation involves dentine, the filling should be performed before the Icon treatment as the hydrochloric acid of the Icon Etch could lead to a decrease in the adhesive's shear bond strength to the dentine.

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Case 1. 3

Masking and arresting of caries during treatment with brackets

Prof. 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 visible aesthetic zone [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 of between 11% [18] and 97% [1] and a WSL incidence between 7% [17] and 73% [15] have been reported. The varying values can be explained, firstly, by different examination methods and, secondly, by the use of different thresholds for detecting WSL.

To prevent caries lesions during orthodontic treatment, optimal oral hygiene is crucial [16]. However, if WSL are detected after an orthodontic treatment, whether a complete remineralisation can be achieved seems to be dependent on the type of lesion [12]. On the one hand, slightly visible, initial WSL often completely remineralise in saliva, since fixed elements – increasing the plaque retention – have been removed. The remineralising 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 for masking 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 colour differences in relation 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 words, the lesion is masked [10, 14].

In several studies on WSL – involving diagnosis 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 enabling 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 of whether the aesthetic outcome could be optimised 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 visible aesthetic zone. 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 minimally 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, randomised 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 follows:

- 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 follows:

a. Etching the teeth with Icon Etch (15% HCl gel for 2 min)
b. Removing Icon Etch and rinsing with the multifunction syringe (30 s per tooth)
c. Drying the teeth with the multifunction syringe (30 s per tooth)
d. Application of Icon Dry (30 s per tooth)
e. Drying the teeth by with 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 grey rubber polisher) and Occlubrush

The steps (a–e) were repeated up to three times – as necessary – until a satisfactory aesthetic 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) (Fig. 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). Colour differences between carious and healthy enamel (ΔE) were then calculated [19].

At baseline no significant difference in ICDAS values (average ± standard deviation) and the ΔE values (mean ΔE: 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 ΔE values could be observed in the test group (Fig. 5–10), whereas no significant change could be observed in the control group (Fig. 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 was 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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CASE 1. 4

Resin infiltration (Icon DMG) of 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 high prevalence of white spot lesions is due to several factors. Oral hygiene for patients with orthodontic appliances, bands and brackets is a challenge. Besides orthodontic hardware being hard to manoeuvre around and clean in between, it provides an increased surface area where plaque and biofilm can 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 the formation of new white spot lesions compared with 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 demineralised 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, with the Icon Etch extruded by twisting the syringe. Etch should extend approximately 2 mm around the edges of the lesion and be applied

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 left on the surface for 30 s 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

Microinvasive 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

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

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Patient history or aetiology. Ingestion of excessive fluoride during enamel formation

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

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

Border. Irregular, distinct or diffuse opacities

Colour. 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

Fluoride plays 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 was exposed to during enamel formation/maturation. [1, 3]

Clinically, mild dental fluorosis is characterised by a diffuse whitish opaque appearance caused by a porous/hypomineralised sub-surface 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/mineralisation. [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 aesthetic perception caused by fluorosis, according to its severity, can generate frustration, embarrassment and concern when smiling, as well as potentially impact the quality of life of adults and children. [4,6] More recently, resin infiltration has emerged as a viable alternative for aesthetic treatment of lesions classified as mild to moderate. [2, 5, 7]

In milder fluorosis, the shallower sub-surface porosities are usually adequately infiltrated and the aesthetic results are typically pleasing. In moderate or severe fluorosis, initial mechanical wear of the surface of the affected enamel may be required before resin infiltration, followed by increments of composite resins, as illustrated in some clinical cases presented in this book.

Prof. Leandro Augusto Hilgert

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Case 2.1

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 to be 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 discolouration 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 microabrasion 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 discolourations.

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 an 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. On the basis of calibrated images, Delta E values between healthy enamel surface and fluorosis spots were calculated. Additionally patients were asked how they would 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% H2O2 following Icon infiltration treatment significantly improves Delta E values and the self-estimated appearance after six months. The following two clinical cases visualise the treatment protocol and clinical results with up to six months follow-up.

Cases

Two female patients (aged 24 and 27) 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 the infiltration procedure. Every patient in the test group received 3 cycles of light-enhanced power bleaching, with each cycle lasting for 15 minutes.

Fig. 5 and 6: Bleaching results. After bleaching, teeth are obviously brighter in both cases. Patients preferred this bleached look, however Delta E values did not decrease significantly. These patient-centred findings are not in line with our personal observations. It appears that not only the sound enamel 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 prescribed 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 of sufficiently removing 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 the result of the photoinitiator camphorquinone 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-invasive to microinvasive 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 side, and the latter definitely on the costlier side, resin infiltration is comparably less invasive and less expensive.
- Infiltrating fluorotic teeth is a predictable and efficient treatment option, although 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. Vera Mendes Soviero

Fig. 1–2: In a clinical exam, it was diagnosed that all of permanent anterior teeth, which were erupted, had fluorosis. However, teeth 11 and 21 were more severely affected according to the 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 concerning the use of infiltrant resin to mask diffuse opacities. A male patient, aged 12, attended the Paediatric Dentistry clinic of the Rio de Janeiro State University, Rio de Janeiro, Brazil. In a clinical examination, it was diagnosed that his 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 and the results 1 week and 4 months after the treatment were satisfactory. The use of infiltrant resin (Icon) can mask diffuse opacities improving aesthetics without any 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 mineralisation, characterised by porosity of the enamel subsurface [1]. Clinically, fluorosis can be seen as slight accentuations of the perikymata, diffused opacities with an 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 as 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], although this procedure also results in a loss of tooth tissue. Infiltrant resin has been used to mask white spot lesions [8, 9], because this resin has a refractive index similar to apatite crystals. It reduces light refraction and, consequently, the colour differences of enamel [10]. As the fluorotic enamel is porous [11], like the white spot lesions, the resin infiltration can be a good alternative for masking the opacities. Thus, this paper aims to describe a case report involving 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) was assisted at the Paediatric Dentistry clinic of the Rio de Janeiro State University, Rio de Janeiro, Brazil.

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

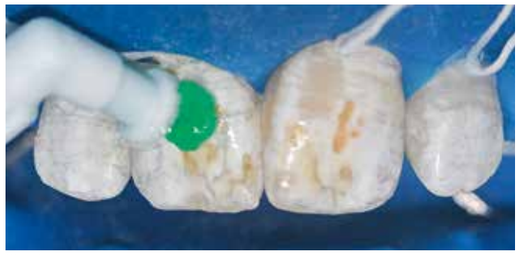
Fig. 4


Fig. 5

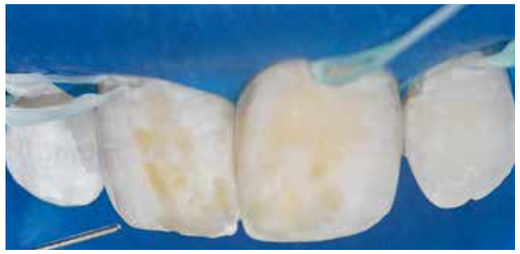
Fig. 6


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 performed 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 gentle friction was applied 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, followed by light-curing of each tooth for 40 seconds.

Discussion

Whenever an aesthetic procedure is recommended, it should be based on the patient's wishes. 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 was very distressed about the appearance of his teeth. Thus, the decision to treat the upper incisors aesthetically came from the patient's wish to have non-discoloured teeth. As infiltrant resin has been used to mask white spot lesions [8, 9], it was decided to use 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 lower 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-mineralised 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. Applying Icon Etch three times was necessary to achieve complete erosion of the surface layer, allowing the infiltrant to penetrate as it does 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 finalise 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, polymerisation shrinkage and resin colour, can also interfere in the final result [10]. In this case, the rubber dam impeded the setting process of Icon 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 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 demineralised 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 aesthetics without a significant loss of tooth tissue.

Key learnings

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

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Case 2. 3

Combination of resin infiltration and composite resin in the treatment of severe dental fluorosis

Prof. Leandro Augusto Hilgert, Marília Bizinoto Silva Duarte

Fig.1: Base status

Enamel developmental defects may negatively affect aesthetics and patients' self-esteem [1]. This is particularly true for young patients. For these cases, treatments should be able to present an acceptable aesthetic result without compromising much tooth structure (being minimally invasive). Resin infiltration has been shown to be a microinvasive treatment for white spot lesions, slight to moderate fluorosis and some other types of opacities [2, 3]. However, in more severe cases, in which tooth substance loss is already present and/or opacities are too opaque and deep, a combination of resin infiltration and composite resins (»deep infiltration«) may be an effective, fast and minimally invasive approach to improve aesthetics [4]. Fluorosis is characterised by hypomineralisation of the enamel [5]. In less severe cases the subsurface hypomineralised enamel may be resin-infiltrated only in a true microinvasive treatment approach. The aim of this case report is to present a severe case of fluorosis in which due to enamel loss and deep opacities a combination of resin infiltration and composite resin restorations was used in the treatment of a young patient.

Case report

A young female patient presenting a severe case of fluorosis came to the University clinic seeking aesthetic treatment. The discussion of medical history revealed that the child was shy and afraid of smiling, and there had already been some episodes of bullying at school due to the enamel development defects. However, there was a concern by the child and her mother on the possible complexity, costs and invasiveness of the necessary treatment approach. Intra-oral examination showed a fluorosis graded as TF6, presenting regions of white opacities as well as some enamel pitting with substantial amount of enamel loss. Transillumination suggested areas of deeper hypomineralisation (where light transmittance was blocked) as well as some areas with more shallow lesions. Proposed treatment plan was resin infiltration and small additions of composite resin. Patient and mother were informed of the treatment steps and the possible need for some localised wear of the enamel in the regions that already presented enamel pitting and discolouration and in the areas with deeper opacities.

Fig. 2

Fig. 3

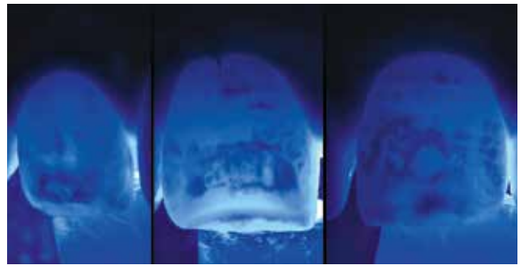

Fig. 4

Fig. 1–4: Figures 1, 2 and 3 present different views of the clinical case in which the patient presents fluorosis (TF6). Observe that there are areas with diffuse and slight white opacities, areas with very opaque white opacities and areas already presenting enamel loss and some discolouration. In Figure 4 transillumination was performed to check light transmittance through the enamel, which may be a useful diagnostic tool since the deeper the enamel hypomineralisation, the more light is blocked. Some areas of the affected anterior teeth area suggested the presence of deeper lesions, which may impair a more complete resin infiltration without some previous wear of the enamel.

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 5–8: After isolation of the operatory field using lip retractors and a liquid dam to protect soft tissues (Fig. 5), Icon Etch (hydrochloric acid) was applied to the surfaces for 2 mins (Fig. 6), with the aim of removing the enamel surface layer and providing access to the sub-surface hypomineralised enamel (porous area). In Figure 7 it is possible to observe the matt appearance after the acid etching. In Figure 8, a drop of Icon Dry (alcohol) was applied to the etched surfaces. After a few seconds, it is possible to see that some areas around the enamel pitting remained very white and opaque. This »visual test« after etching may be useful to indicate areas in which more pronounced enamel wear is needed to provide access to the hypomineralised layer. This extra step may be performed with repeated acid etchings or, in deeper lesions, with air abrasion or rotary instruments.

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 9–12: In this case we opted for diamond burs to wear the surface. Localised preparations were performed, removing the superficial part of the more affected enamel and areas of discolouration (where enamel pitting was already present) (Fig. 9). Icon Etch was then applied once more for 2 mins (Fig. 10). Figure 11 shows the aspect after localised enamel wear and acid etching. It possible to see that there are still whitish areas that could be infiltrated. After etching, Icon Dry was dripped onto the surfaces (Fig. 12). Observe the more uniform aspect after alcohol application, indicating that better access to the porous areas was achieved. Once the result was good, Icon Dry was left for 30 s and surfaces thoroughly dried.

Fig. 13–16: Icon Infiltrant (the low-viscosity resinous infiltrant) was applied according to manufacturer's instructions (3 min, excess removal, light-curing; 1 min, excess removal, light-curing) (Fig. 13). In Figure 14 it is possible to see the aspect immediately after infiltration in which a uniform colour was achieved and most of the whitish opacities were adequately masked. This uniform substrate eases composite resin stratification and improves the final result since there is no need to mask white spots with opaque composites. Areas of worn enamel and previous enamel pitting were restored using only body and enamel shades (Fig. 15). It is interesting to note that after resin infiltration, if the surface was not contaminated, it is not necessary to apply an adhesive. Methacrylate-based composites effectively adhere to the infiltrant [6]. Figure 16 shows that the tooth anatomy was correctly recovered. After composite resin application, a careful finishing and polishing procedure was performed on the infiltrated and restored surfaces using abrasive discs, rubber cups and polishing pastes.

Fig. 17

Fig. 18

Fig. 17–18: Figures 17 and 18 show the immediate results achieved after using a combination of resin infiltration and composite resin. Aesthetics were significantly improved. Patient and mother were very satisfied. Even though some enamel wear was needed, we considered this a simple, cost-effective, fast and minimally invasive approach to dealing with the clinical situation. Compare post-treatment pictures with Figures 1 to 3.

The presented treatment shows that a combination of resin infiltration and composite resin may be an interesting approach to severe cases of fluorosis or other enamel defects that are non-responsive to resin infiltration only. The localised wear performed with abrasive instruments removes the highly affected enamel and exposes the underlying porosities that are then able to be adequately infiltrated (a technique known as »deep infiltration«). The advantage of infiltrating the (still porous) sub-surface enamel before covering it with composites is that a uniform substrate is achieved, avoiding the need to use opaque dentine shades, that in low thicknesses either do not mask the whitish underlying enamel or do not present the expected life-like aesthetics and translucency of the enamel. Learning from cases like this about the limitations of using resin infiltration alone, but its usefulness when combined with localised preparations and composite resin restorations, allows the dentist to have new treatment possibilities aimed at a highly aesthetic outcome with a minimally invasive approach.

Key learnings

- Severe fluorosis or other very opaque (deep) enamel defects may require previous enamel wear to allow underlying hypo-mineralised enamel to be adequately infiltrated.
- »Deep infiltration« promotes a uniform substrate that facilitates obtaining pleasing aesthetic results with thin (and conservative) increments of body and enamel shades of composite resins.
- Bonding to composites after resin infiltration does not require an additional adhesive step. If, after the infiltrant final light-curing, there is no contamination of the operatory field, composite increments may be directly applied onto the infiltrated surfaces.

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Case 2. 4

Fluorosis infiltration – case study of a young patient

Dr Arzu Tuna, Dr Umut Baysal, Dr Rainer Valentin

Fig. 1: Frontal view of the white spots 11, 21

Fig. 2: Firstly, the teeth should be cleaned or (as in our case) a professional dental cleaning should be done. The mucous membranes are protected by using a dental dam

As part of a routine examination, our patient reported an increasing urge to do something about the white spots on her anterior teeth (Fig. 1). After weighing up various therapy options, it was jointly decided that infiltration was the treatment of choice [1].

In numerous studies there is evidence of almost optimal matching of infiltrated (orthodontic) white spot lesions to the shade of the natural tooth enamel [2, 3, 4, 5].

In terms of the localisation, form and patient's history, the white spots on the labial surfaces of teeth 11 and 21 are classified as fluorosis with severity 0.5 (community fluorosis index according to Dean). Masking of the white spots using infiltration is based solely on altering the refractive index near the whitish opacities. Healthy enamel has a refractive index (RI) of 1.62. The different refractive index at the margins causes light to scatter, which gives the lesion a whitish appearance [6]. Regardless of whether the porosities are caused by incipient caries or a mild fluorosis, in the initial stage they appear as whitish staining to the human eye due to the lower refractive index. Infiltration of this area will change the refractive index and mask the opacities. Most of the data on infiltration in the labial surfaces of the anterior teeth are from patients following orthodontic multiband treatment. The resultant white spots can be very easily and permanently eliminated using infiltration [7, 8].

The success of the infiltration is highly dependent on the level of fluorosis damage. With very mild to moderate fluorosis, the infiltration technique has been successfully used in vitro as an intervention for fluorosis [9]. Nevertheless, we decided to use infiltration because it is the least invasive treatment option in this case. If the infiltration was not successful, it would not prevent a more invasive treatment method. A combination of the infiltration with composite treatment is definitely possible. This is because even with simultaneous composite treatment of enamel surfaces affected by caries, no additional adhesive is required for the enamel. Only once dentine is involved do appropriate adhesives have to be used [10]. Therefore, there is nothing preventing an invasive composite treatment subsequent to successful infiltration (successful from an aesthetic perspective). What is noteworthy is that the infiltrated teeth can be bleached with standard methods. The results are comparable with the effects that can be achieved with non-infiltrated teeth. This means that unwanted shade changes in the form of uneven shading of the teeth are of no concern [11, 12].

Key learnings

- Icon Infiltrant can penetrate into porosities in fluorosis white spots and thereby minimise the difference in refractive index between the health enamel and fluorosis white spots.
- The number of etchings will be decided according to the assessment in the Icon Dry step. When the expected result is not achieved, the white spots need to be etched and dried again before infiltration step.
- Icon infiltration is a promising and microinvasive treatment for the patient impaired by fluorosis white spots.

Fig. 3

Fig. 3: After application of a dental dam, the entire labial surfaces were etched for two minutes with Icon Etch. The procedure was repeated because the initial result was not satisfactory. During the drying with alcohol, there is a preview of the colour change. The result was unsatisfactory, which in this case led to etching being performed three times.

Fig. 4

Fig. 4: After each etching procedure, Icon Dry was used for drying after the acid had been thoroughly sprayed off.
Fig. 5: The Icon Infiltrant was then applied and left on for three minutes, the excess was removed and this was followed by light-curing. This procedure was repeated with the option of shortening the application time (one minute).
Fig. 6–7: After polishing, the treatment was complete and the patient was impressed by the final result.

Fig. 5

Fig. 6: Results immediately after treatment

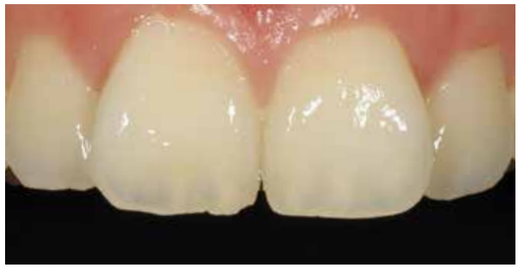

Fig. 7: The appearance after three months

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Case 2. 5

Resin infiltration showing immediate aesthetic improvement in non-pitted fluorosis

Prof. Neeraj Gugnani

Fig. 1

Fig. 2

Dental fluorosis is caused by ingestion of excess amounts of fluoride, mainly through water, and leads to aesthetic alterations of teeth. Fluorosis is prevalent in countries which lack moderated community water supplies where people usually drink ground water having fluoride more than the stipulated limit of 1 ppm.

Dental manifestation of fluorosis may vary from non-pitted white opacities / brown stains covering partial or complete tooth surface(s) to pitted tooth surfaces.

Conventionally, dentists have treated these non-pitted fluorosis lesions with bleaching, microabrasion and composite veneering, while on the other end of the scale, laminates/crowns are frequently provided for pitted fluorosis teeth. However, recently a novel microinvasive resin infiltration technique has been introduced which has shown promising results for the treatment of demineralised white spot lesions, in terms of both stopping the progress of these lesions and improving the aesthetics [1].

Later the technique was tried by many dentists worldwide for other hypomineralised lesions, including fluorosis, hypomineralised developmental defects, molar-incisor hypomineralisation cases, trauma induced mineralisation defects etc. [2, 3].

Clinical case

The present clinical case is of a patient who had chalky white opaque areas covering the whole tooth/teeth due to fluorosis. It was decided to treat the lesion using a microinvasive resin infiltration procedure, using the Icon Vestibular kit (DMG, Germany) for which informed consent was obtained from the patient.

The Icon Vestibular kit contain three syringes, along with applicator tips for facial surfaces, each to be used in the three-step procedure for the application of resin infiltration, namely 1. etching: Icon Etch which is composed of 15% hydrochloric acid, 2. drying agent: Icon Dry, composed of ethanol, 3. infiltrant: Icon Infiltrant, composed of infiltrant with very low viscosity resin allowing it to infiltrate in the body of the lesion.

The tooth represented in this clinical case is no. 12, which was isolated with rubber dam, with the white opacity covering the whole tooth visible in the pre-operative clinical picture (Fig. 1). This was followed by application of Icon Etch for 2 minutes (Fig. 2).

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Icon Etch was washed off for 30 seconds and the tooth was dried with oil-free air. Etching was repeated again for 2 more minutes. Next the drying agent (Icon Dry) was applied for 30 seconds (Fig. 3), which then evaporated leaving the accentuated pores, making it easy for infiltrant to seep in. Lastly the infiltrant was applied (Fig. 4) and was left in place for 3 minutes followed by light-curing of the infiltrant for 40 seconds (Fig. 5) and a repetition of infiltrant application for one more minute. Immediate improvement in aesthetics and good patient satisfaction was observed (Fig. 6).

Key learnings

- It can be concluded that resin infiltration can be used for non-pitted white opacities which are due to fluorosis.
- In fact the literature suggests that resin infiltration can be used for any kind of hypomineralisation defects, although variations in the etching times and number of infiltrant applications are required, which depends on the depth of the lesion and should be judged clinically on a case-by-case basis [4, 5, 6].

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Case 2. 6

Resin infiltration as a microinvasive treatment for fluorosis

Prof. Leandro Augusto Hilgert, Marília Bizinoto Silva Duarte

Fig. 1

Fig. 2

A 26-year-old female patient presenting mild to moderate fluorosis was looking for aesthetic treatment. Her main complaint related to the whitish diffuse opacities that affected her smile

Fluorosis is observed, clinically, from mild diffuse white opacities on the enamel to severe whitish/brownish staining end enamel surface malformation. These conditions may compromise aesthetics according to their severity. For light to moderate fluorosis, the most common cases, there are reports that resin infiltration may successfully mask the opacities improving aesthetics with very low enamel wear. The aim of this case report is to present a step-by-step description of the resin infiltration technique as a microinvasive alternative for the aesthetic treatment of fluorosis. Considerations on how to diagnose depth of the opacities and on how many times to etch the enamel to improve results predictability are presented. The main features of the resin infiltration technique and other established aesthetic treatments for fluorosis are discussed.

Introduction

Fluorosis is characterised by sub-surface enamel hypomineralisation (porosities) caused by excessive fluoride intake during enamel development [1, 2]. In mild to moderate cases of fluorosis, the lower refractive index (RI) of the porosities contents gives the enamel a diffuse whitish opaque appearance that, for some patients (depending on fluorosis severity), may be aesthetically unpleasant.

Many treatment options are available for fluorosis, such as: (a) bleaching, which can possibly reduce the contrast between whitish opacities and sound enamel; (b) microabrasion, in which the surface and sub-surface of the affected enamel are worn out by a combination of acids and abrasives, exposing the underlying sound enamel; (c) macroabrasion, where preparation is performed on the affected fluorotic areas followed by a restoration; and, (d) resin infiltration, a technique that involves a very mild wear of the surface enamel, exposing the porous sub-surface, which is subsequently infiltrated by a low-viscosity resin that has an RI more similar to sound enamel [3, 4].

Usually, bleaching alone is not capable of providing a complete optical blending of the fluorotic and the sound enamel. Micro- and macroabrasion techniques are effective, but require a more invasive approach, removing the whole affected enamel. Resin infiltration appears to be a suitable alternative that combines good results with very low invasiveness.

The aim of this case report is to describe in detail the resin infiltration protocol in the aesthetic treatment of a mild to moderate fluorosis case.

Case report

A 26-year-old female patient presenting mild to moderate fluorosis was looking for aesthetic treatment. Her main complaint concerned the whitish diffuse opacities that affected her smile (Fig. 1 and 2).

The patient, a dentist, was questioned on how pleased she was with the shade of her teeth and she answered that she would like a more natural, less white appearance. This is a crucial question since after treating mild/moderate fluorosis teeth will become more chromatic and present less value. Therefore, patients that prefer a very white shade should be advised to bleach before treating the fluorotic lesions.

The patient was very pleased with the aesthetic result that was obtained with a microinvasive approach.

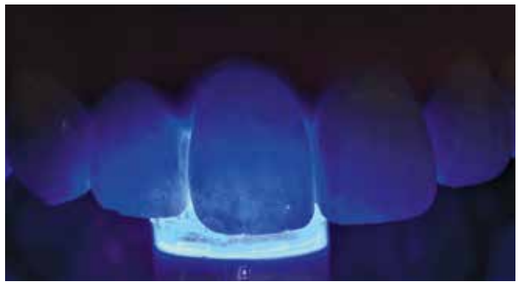

Fig. 3

Fig. 3: To evaluate the depth of the affected enamel, a clinically useful tool is to perform transillumination. Specific equipment or even a simple light-curing unit can be positioned on the lingual surface and made to emit light. When there is little or no blockage of the transmitted light by the opacities, the lesions (enamel porosities) are shallow and the probability of less invasive therapies being effective is higher. In the present case, this was the situation and the fluorotic lesions were judged to be shallow, indicating a good prognosis for resin infiltration.

Fig. 4

Fig. 4: The next step is isolating the teeth that will be infiltrated. Field isolation and protection of the gingival tissue can be achieved using a rubber dam or a liquid light-cured resin dam (Top Dam, FGM, Brazil) together with cheek, lip and tongue retractors. While the liquid dam is usually faster and easier to apply, a rubber dam may present a more intense gingival retraction that may improve results in the cervical area. In this case, the liquid dam was selected and carefully applied to cover as little enamel as possible.

Fig. 5

Fig. 6

Fig. 5–6: Resin infiltration protocol begins with etching of the surface enamel using a 15% hydrochloric acid gel (Icon Etch, DMG, Germany) that should stay in contact for 2 minutes, with the aim of wearing the surface layer and exposing the porous hypomineralised subsurface. After suctioning the acid gel, rinsing and air-drying the enamel, a drop of ethanol (Icon Dry, DMG, Germany) is applied to the etched surface and the observed optical aspect of the white opacities should already be minimised. If the opacities are still very visible when the ethanol is applied, a second (or even a third) etching step is indicated.

In the present case, in Figure 5, it is possible to observe the aspect after a single etching procedure. Since the opacities were still very visible it was decided to repeat the etching step once more. In Figure 6, it is possible to see the difference between the aspect after one and two etching steps as a drop of Icon Dry was applied to the etched enamel surface. Since the result was satisfactory, the ethanol was left on the surface for 30 s to promote a thorough desiccation of the enamel, followed by air-drying.

Fig. 7

Fig. 8

Fig. 7–8: On the etched and dry enamel, the low-viscosity infiltrant (Icon Infiltrant, DMG, Germany) is applied and should remain for at least 3 minutes to achieve maximal infiltration depth into the porosities of the hypomineralised enamel. In Figure 7 it is possible to observe the aspect after infiltrant application on the right upper teeth, while the left have not yet received the resin. After all teeth have received the infiltrant and the 3-minute waiting period has been observed, obvious excess can be removed using a gauze and light-curing is performed (Fig. 8). It is paramount to execute a thorough polymerisation using adequate irradiance and exposure time (40 seconds per tooth). A second application of the infiltrant should be performed for 1 minute followed by excess removal and light-curing.

Fig. 9: It is possible to see the immediate aspect after infiltrant polymerisation. It is normal to observe a shiny and irregular appearance due to excess of the infiltrant covering the surface. This material is easily removed with polishing instruments as abrasive discs, spirals or rubber cups

Fig. 10: In the present case polishing was performed using discs and spirals (Sof-lex, 3M, USA)

Fig. 11

Fig. 12

After polishing, the result of the treatment is shown in Figures 11 and 12. Almost all white opacities disappeared, indicating a satisfactory infiltration of the fluorotic enamel

Discussion

An ideal aesthetic treatment is the one that can please the demands of the patient, that requires very little wear of sound enamel (low biological cost), that can be executed simply and quickly and that lasts.

Patients that present fluorotic enamel may not require any kind of aesthetic treatment, especially if presenting a mild severity of the lesions [5]. However, whenever a treatment is required, the dentist should be able to offer treatment options that present efficacy, low invasiveness and durability.

Resin infiltration is a technique based on the acid dissolution of the well-mineralised surface layer of the enamel (with a thickness of around 30–40 µm) [6], exposing the porous hypomineralised enamel of the sub-surface. After thorough drying, a low-viscosity resin is infiltrated into the porosities of the enamel by capillary forces filling the spaces with a material that has a closer refractive index to sound enamel. Therefore, the optical appearance of the infiltrated enamel blends with the sound enamel, significantly improving the aesthetic harmony of the smile [7–9].

For the infiltration process to be effective, the first step is to diagnose the type of white opacity. Deeper lesions that are very opaque to transillumination (as in some molar-incisor hypomineralisation cases) usually do not present the best results for any kind of less invasive treatment and may require some localised tooth preparation. Shallow to medium-depth lesions, such as those depicted in the case report, that clinically do not block the light passage during transillumination (see Fig. 3) usually have a favourable prognosis for resin infiltration.

Next, another fundamental step for a successful resin infiltration is adequate removal of the well-mineralised surface layer to expose the porous subsurface. If adequate access for the resin to infiltrate the porosities is not achieved, the technique will not present the best results. A very effective way of testing if the surface layer was removed after the acid etching step is observing what happens when a drop of ethanol is applied to the etched enamel. If the optical result already looks good, the surface layer was properly removed. If the white opacities are still very visible, a new etching step should be performed (see Fig. 6, which depicts the difference between one and two etching steps). This is an easy and simple method for deciding whether re-etching is necessary before the drying and infiltration steps.

It is imperative for the dentist to realise that the main difference between resin infiltration and microabrasion is that in the first method the porous enamel is preserved and infiltrated while in the later method aesthetic success is based on complete removal of the affected enamel. That is why the technique is indicated for lesions no deeper than 0.2 to 0.3 mm (200 to 300 µm) [10]. Therefore, it is clear that microabrasion is a more invasive alternative, requiring much more enamel wear to produce pleasant results.

The colour stability of the resin-infiltrated enamel has been tested in vitro [8] and in clinical studies [11] and presented in numerous case reports [4, 12–15]. So far results are positive and very promising. This hybrid structure of enamel/infiltrant (the inifltrated enamel) can be successfully submitted to the daily »polishing« of oral hygiene and can be polished by the dentist in routine clinical sessions.

Based on the substantial amount of available scientific evidence, clinical reports and our clinical experience of almost eight years conducting resin infiltration treatments, this approach has become our standard of care in treating light to moderate fluorosis. It is important to note that for many patients who desire treatment of the fluorotic opacities and want to have whiter teeth, a bleaching procedure is usually performed before resin infiltration [16].

Conclusion

Resin infiltration seems to be a successful microinvasive treatment for the aesthetic treatment of light to moderate fluorosis.

Key learnings

- Resin infiltration is a microinvasive approach for the treatment of slight to moderate fluorosis.
- Additional acid etchings may be necessary to improve resin infiltration. Observing the visual aspect when applying Icon Dry may be a good way of determining the need for repetition of the etching step.
- Removal of Icon Infiltrant excesses before light-curing and adequate finishing and polishing after light-curing are important steps for promoting a good surface texture.

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Case report: masking of fluorosis with resin infiltration

Prof. Sebastian Paris

Fig. 1: Initial situation

Fig. 2: After cleaning with prophylaxis paste, the affected vestibular area was initially conditioned for 2 minutes with 15% hydrochloric acid gel (Icon Etch, DMG). At this juncture, the more heavily mineralised surface layer was removed. This shows fewer pores as a result of remineralisation processes than the lesion underneath and would thus prevent the infiltrant from penetrating. After 2 minutes, the etching gel was water-sprayed off and the lesion carefully dried

Fig. 3: To achieve further deep drying and at the same time check whether sufficient abrasion of the surface layer was achieved, ethanol (Icon Dry) was subsequently applied to the lesion. Due to penetration of the ethanol into the lesion's porosities, similar to the later infiltration with resin, the light refraction within the caries was reduced, making the lesion appear less whitish-opaque. When this effect can be observed in the first 2–5 seconds after application of the ethanol, the surface layer is sufficiently abraded to guarantee a quick and complete infiltration

A 19-year-old patient presented in the university outpatient clinic requesting treatment of whitish spots on her teeth, which she found aesthetically disturbing. According to the patient, the spots had been visible ever since her adult teeth came through. For this reason, composite fillings had already been placed on the anterior incisors. After a visual-tactile examination, the discolourations were diagnosed as dental fluorosis. Whitish opaque discolourations of the tooth enamel, or brownish opaque discolourations in severe cases, are characteristic of dental fluorosis cases. These discolourations are mostly located outside the traditional caries predilection sites. The whitish changes often affect several teeth, are poorly defined, are more clearly visible when the teeth are dried and are accentuated on the perikymata. Another characteristic is so-called »snow capping«, a whitish discolouration of the incisal third of the teeth (Fig. 1).

Various therapy options were discussed with the patient, including bleaching, resin infiltration, microabrasion and composite restorations, while the associated necessity for tooth structure removal, the predictability of the aesthetic result, the long-term prognosis and the costs were weighed up against each other.

The patient opted for resin infiltration due to the relatively low tooth structure removal, good predictability and manageable costs.

For a better estimate of the aesthetic result, the most severely affected tooth (13) was treated first. In the present case, there was no isolation with rubber dam because desiccation and protection of the soft tissue could be guaranteed by an adequate distance from the gingiva.

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Key learnings

- When Icon Dry was applied to the lesion, the lesion was masked and it appeared less whitish opaque due to the penetration of the ethanol into the lesion's porosities. This effect should be observed in the first 2–5 seconds after application of the ethanol. If this effect takes longer to occur, this most often indicates that the lesion should be etched again.
- Polishing after infiltration treatment is very important for removing the oxygen inhibition layer on the resin.
- When several lesions need to be treated, it will be better to treat one of the lesions first to make sure Icon infiltration treatment works well on this patient and also give the patient more confidence to go ahead with the subsequent treatment.

Fig. 4: If the colour change is slower, this most often indicates that the surface layer has not been eroded completely. In this case, the lesion should be etched again. In the present case, the lesion was etched again for 2 minutes, the etching gel subsequently sprayed off, the lesion dried with compressed air and ethanol applied once again. **Fig. 5:** At this juncture, an instant (<2 seconds) disappearance of the lesion's opacity could be observed, which indicates adequate removal of the surface layer. In preparation for the subsequent infiltration, the ethanol was vaporised with compressed air and the lesion consequently dried thoroughly. **Fig. 6–7:** The infiltrant (Icon Infiltrant, DMG) was applied in the subsequent step. It could also be observed here how the resin penetrated the lesion and adapted its colour to the surrounding tooth enamel. **Fig. 8:** Even though the lesion was fully masked after a few seconds, the excess resin was only removed from the lesion surface with a foam pellet after 3 minutes. **Fig. 9:** The resin then underwent light-curing for 40 seconds. To compensate for the infiltrant's polymerisation shrinkage, the resin was applied again and cured again after 1 minute (no illustration). Thanks to the oxygen inhibition of the polymerisation of the resin surface layers, a thin raw unpolymerised resin layer remains on the enamel surface. This should be removed by polishing. In the current case, polishing was carried out with polishing discs (Sof-Lex, 3M Espe). **Fig. 10:** The final result on tooth 13 was very satisfactory immediately after the treatment. The remaining teeth (12–23) were thus subsequently treated as described above and showed complete masking of the fluorosis immediately after treatment.

Case 2. 8

Minimally invasive aesthetic restoration for severe dental fluorosis – combining resin infiltrating with at-home bleaching

Dr Ryan Li

Fig. 1: Before treatment. The full dentition exhibited mottling and defects. We chose at-home bleaching first to improve the colour of the teeth

Dental fluorosis is an extremely common disorder, characterised by hypomineralisation of tooth enamel caused by ingestion of excessive fluoride during enamel formation.

It appears as a range of visual changes in enamel, causing degrees of intrinsic tooth discolouration and, in some cases, physical damage to the teeth. The severity of the condition is dependent on the dose, duration and age of the individual during the exposure. The »very mild« (and most common) form of fluorosis is characterised by small, opaque, »paper« white areas scattered irregularly over the tooth, covering less than 25% of the tooth surface. In the »mild« form of the disease, these mottled patches can involve up to half of the surface area of the teeth. When fluorosis is moderate, all of the surfaces of the teeth are mottled and teeth may be ground down and brown stains frequently »disfigure« the teeth. Severe fluorosis is characterised by brown discolouration and discrete or confluent pitting; brown stains are widespread and teeth often present a corroded-looking appearance.

People with fluorosis are relatively resistant to dental caries (tooth decay caused by bacteria), although they may be of cosmetic concern.

In moderate to severe fluorosis, teeth are physically damaged. Traditional treatment options for dental fluorosis are porcelain laminate veneer or all-ceramic crowns, which are invasive and expensive. These treatments normally require long clinical procedures (several appointments). A combination of resin infiltrating technology and at-home bleaching is a minimally invasive method for treating dental fluorosis and easy to apply. It is therefore more acceptable for patients.

Clinical case

A 23-year-old female patient complained of severe discolouration and discrete pitting on anterior teeth and hoped to improve tooth appearance. After clinical examination, severe dental fluorosis was diagnosed. We offered a treatment protocol – minimally invasive aesthetic restoration combining resin infiltrating with at-home bleaching.

Fig. 2: After the comprehensive clinical examination, colorimetric analysis was performed and the colour of the teeth was recorded. We made a custom bleaching tray for the patient and gave instructions for at-home bleaching and oral health instruction. After using eight units of Opalescence PF 10 % for four weeks, the colour of teeth improved dramatically. We began the Icon resin infiltration treatment

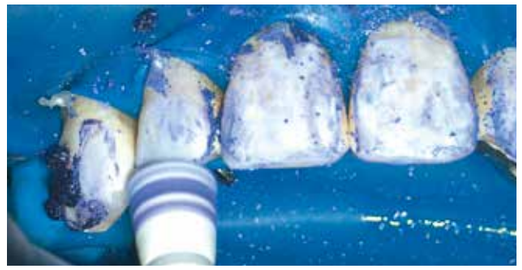

Fig. 3: The use of rubber dam is essential when Icon is applied. After cleaning the teeth, a rubber dam was applied to isolate the operative site from the rest of the mouth. Tooth cervix was tied off with dental floss. Opalustre grinding paste, a 6.6% hydrochloric acid slurry containing silicon carbide microparticles, was applied to the tooth surface. Polish for 60 s with low speed dental handpiece and rubber cup with medium pressure. Rinse the grinding paste and evaluate the effect

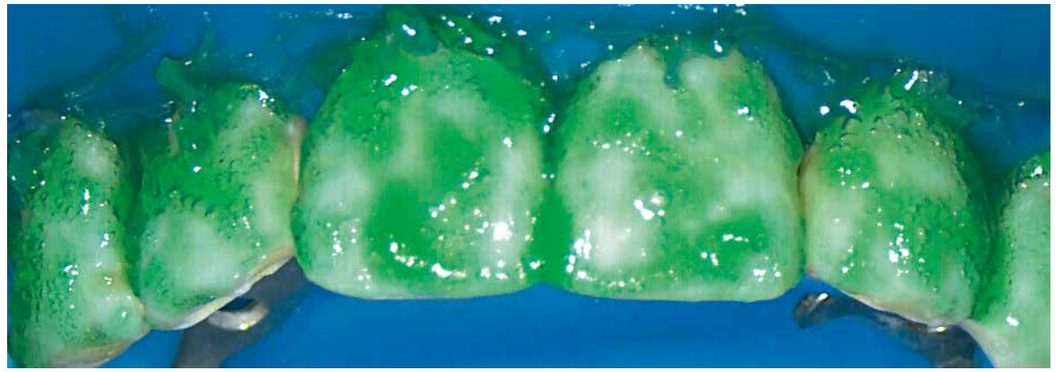

Fig. 4: Icon Etch was applied for 2 minutes and sprayed with water and air for 30 seconds. Dry with oil-free and water-free air

Fig. 5: 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. In this step a preview of the final result is shown. When wetted with Icon Dry, the whitish-opaque colouration on the etched enamel should diminish. The result of the visual check after the first etching showed that the second etching was necessary

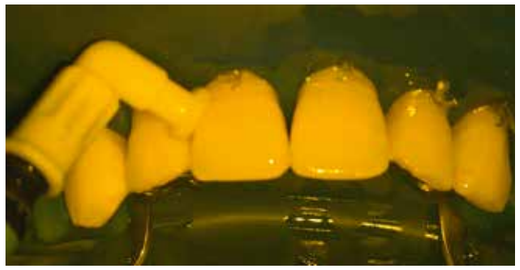

Fig. 6

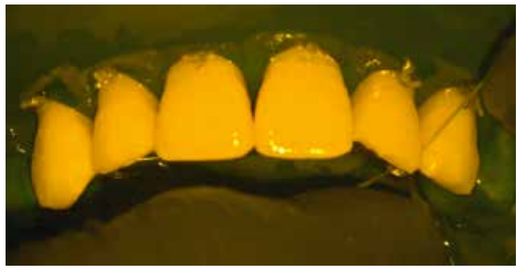

Fig. 7

Fig. 8

Fig. 6 and 7: After the second application of Icon Etch and Icon Dry, the result of the visual check was satisfactory. After drying the enamel surface, apply an ample amount of Icon Infiltrant onto the etched surface under a secure light source. Allow Icon Infiltrant to set for 3 minutes. The Infiltrant will be activated by slightly moving the applicator. Remove excess material with dental floss. Light-cure palatal side firstly, then labial side

Fig. 8: Use ENA HRi aesthetic restorative system (UD3+UE3) to fill enamel defects

Fig. 9

Fig. 9: Screw a new Vestibular Tip onto theIcon Infiltrant syringe, repeat the application and allow to set for 1 minute. Remove excess material with a cotton wad and dental floss. Apply antioxidant and light-cure palatal side firstly, then labial side

Fig. 10: Polish the teeth surface with wool polishing wheel and ENA SHINY A, B, C paste

Fig. 11: Immediately after the removal of the rubber dam, the aesthetics of the upper anterior teeth is visible. The mandibular anterior teeth achieved the effective result with the same steps. Immediate postoperative aesthetics

Fig. 12: Frontal view of the confident smile on her face!

Discussion

The clinical manifestation of dental fluorosis is that dental enamel developed in the same period has chalk spots or brown spots. Severe dental fluorosis can accompany discolouration with defects. Discolouration can be treated with dental bleaching. Dental bleaching utilises hydrogen peroxide or carbamide peroxide which can diffuse into the tooth and dissociate to produce unstable free radicals. Free radicals will attack organic pigmented molecules in the spaces between the inorganic salts in tooth enamel by attacking double bonds of chromophore molecules within tooth tissues [1, 2, 3]. The change in double-bond conjugation results in smaller, less heavily pigmented constituents, and there will be a shift in the absorption spectrum of chromophore molecules; thus, bleaching of tooth tissues occurs.

Enamel microabrasion works with the abrasive paste which is 6.6% hydrochloric acid slurry that contains silicon carbide microparticles. Chemical corrosion and mechanical abrasion occur simultaneously in order to remove enamel defects and make the enamel smooth and glossy. Compared with invasive methods like porcelain laminate veneer and all-ceramic crown, enamel microabrasion can preserve a more natural dental structure.

Resin infiltration technique is an alternative therapeutic approach, the principle of which is capillary siphoning to prevent further progression of enamel lesions. This treatment aims to occlude the micro-porosities within the lesion body by infiltration with low-viscosity light-curing resins that have been optimised for rapid penetration into the porous enamel. Because the infiltrating resin's refractive index is closer to that of natural enamel, it changes the lower refractive index of decalcified enamel and makes the teeth bright. Therefore this treatment may be used not only to arrest enamel lesions but also to improve the aesthetic appearance of anterior teeth.

Conclusion

Resin infiltrating combined with at-home bleaching and microabrasion can treat dental fluorosis effectively. Besides, it results in minimal invasion on the dental hard tissue and is easy to apply. It can also save time and money for patient. In short, the infiltration technique is the most favourable option for the dental fluorosis patient.

Key learnings

- A patient suffering from severe fluorosis can be treated effectively with Icon infiltration treatment. This is normally combined with some other treatments, for example bleaching, microabrasion or composite restoration.
- Icon infiltration cannot eliminate yellow or brown staining, so bleaching normally needs to be performed by patients with severe fluorosis before infiltration treatment.
- Icon can provide a uniform background for the aesthetic composite restoration.

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Case 2. 9

A non-invasive approach to treating white enamel lesions

Dr Alexander Aresdahl

Whether a patient has brown spots, white spots or both, I always recommend teeth whitening for 2–4 weeks before Icon Vestibular is used. In a few cases, when the brown spots are superficial, a white polishing stone can be used to remove brown staining before initiating treatment.

Transillumination: A good way to determine if a white spot is treatable or not with Icon is to use a light-curing LED. Illuminate the enamel by placing the LED tip on the palatal side of the tooth structure and see if the white spot is translucent or completely opaque. If the white spot is opaque, then the treatment is less likely to be successful and substance removal and composite treatment may be needed.

Fig. 1: Start by applying an Optragate to move the patient's lips out of the way. Then take a white polishing stone and gently polish the enamel surface for a few seconds to get rid of the superficial biofilm on the enamel surface

Fig. 2: Apply liquid rubber dam or classical endodontic rubber dam with ligatures to protect the gingiva

Fig. 3: Blast the white spots with white aluminium oxide. This will enable better access to the body of the lesion. Blasting of the white lesions should only be done for 2–3 seconds and only once, with the blasting tip positioned approximately 1 cm away from the enamel. After completion of this stage the white lesion should present a matte appearance

Fig. 4: Apply Icon Etch over the white lesions and rub it gently for a few seconds with a dry tip until the Etch loses its glide and starts to present a foamy appearance. Let the Icon Etch rest on the surface for 2 minutes and then rinse it off with water for at least 30 seconds

Fig. 5: After careful rinsing of the tooth surface, dry with oil-free and water-free air. Then wet the white lesion with Icon Dry. What you want to see is either a complete temporary masking/disappearance of the white lesion when wetted or a fluctuation in the white colour of the lesion when wetted with Icon Dry. This indicates that the lesion is now accessible for the Icon Infiltrant

Fig. 6: When the white lesion has responded well to Icon Dry, it is time to use the Icon Infiltrant. Move your chair-attached lamp away from the patient's teeth and apply Icon Infiltrant on a dry enamel surface. Use rich amounts. Allow it to infiltrate the surface for 3 minutes. Carefully air-dry the surface followed by flossing, then light-cure for 40 seconds. Repeat the process a second time, but with only 1 minute infiltration time

Fig. 7: After the Icon infiltration process, the enamel surface will present a matte appearance. To achieve a shiny and smooth surface, use 3M polishing disks. Start with a light orange disc on a dry surface and carefully polish away any unevenness. Additionally, rinse the surface with water, air-blast and finish the polishing process by using a yellow disk

Fig. 8: Final result

Key learnings

- Make sure to rub the Icon Etch onto the enamel thoroughly.
- Transillumination analysis pretreatment is a very good clinical indicator of whether you will need to remove tooth substance and use composite in addition to your treatment or if you can use Icon alone.
- For optimal aesthetics use polishing disks to polish the matte surface after the treatment.

Case 2. 10

Masking fluorotic lesions with Icon

Associate Prof. Giuseppe Allocca

Fluoride is one of the most important caries-preventive agents in dentistry [1]. Nevertheless, chronic exposure resulting from excess fluoride intake during tooth development can lead to fluorotic spots on the tooth surface. Especially high concentrations of naturally occurring fluorides in drinking water seem to be the main cause for fluorosis [2].

Histologically, fluorotic enamel is characterised by hypomineralisation, resulting in porosities of the tooth (sub-)surface [1, 3]. The appearance of these spots varies from opaque whitish to unsightly brown spots or even pitting, dependent on the duration and time point of high fluoride exposure during tooth development as well as patient-related factors (e.g. patient's age or individual response) [2].

The main consequence of dental fluorosis is compromised aesthetics [3]. Especially when front teeth are affected by dental fluorosis, dentists often are confronted with the patient's demands of aesthetic improvement as the appearance of these areas can be compromising. Treatment options include bleaching in case of mild forms, while moderate forms of fluorosis can be treated with enamel microabrasion. Severe cases can require composite fillings or even veneers [2, 4]. Infiltration of these fluoride spots with Icon is an alternative treatment option for masking these compromising areas on the tooth surface. In young patients, dentists may want to avoid dental bleaching as well as more invasive treatments. Icon is not only minimally but also microinvasive and can also be applied on young teeth. The low-viscosity Icon resin occludes the lesion porosities. As a result the lesions are masked [3].

Fig. 1: Initial situation of the fluorotic spots before treatment with Icon. The appearance of the teeth 21 and 11 was especially aesthetically compromised

Clinical case report

An eight-year-old male patient with whitish and chalky spots on his upper front teeth came to our dental office with his mother. He was suffering mocking from his classmates due to the appearance of his teeth 11 and 21. In addition to this, his mother raised concerns about the chalky appearance of these spots when her child gets up in the morning. After detailed examination, dental fluorosis was diagnosed and it was assumed that the reduction of saliva moistening of the patient's teeth during the night was promoting the chalky effect in the morning. In order to terminate the patient's psychological distress due to compromised aesthetics, we suggested an Icon treatment to mask the fluorotic lesions.

Discussion

Fluorotic spots can be a burden for patients as they often compromise aesthetics. The clinical treatment goal of this kind of tooth discolouration should be to achieve an acceptable aesthetic result as conservatively as possible. Icon enables masking of these lesions in a microinvasive way as no mechanical enamel removal is required. The surface is just eroded with the Icon Etch to get access to the lesion. Compared with microabrasion or conventional restorative treatment options, Icon is less invasive. Furthermore, the treatment time is shorter compared with other treatment options, which can be an advantage in children with less compliance. Nevertheless, in the same way as in some bleaching and enamel microabrasion techniques, it has to be considered that the treatment result is dependent on the severity of the fluorotic spots. In some cases an improvement but not a completely masking of the spots can be achieved [3].

Conclusion

Treating fluorotic spots with Icon is a microinvasive, short and painless treatment option which improves aesthetics and can also be used in young patients.

Fig. 2

Fig. 3

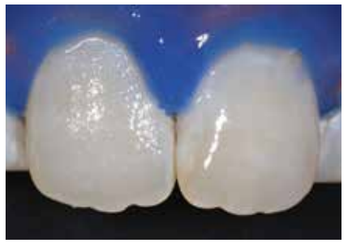

Fig. 4

Fig. 2: After polishing the teeth with pumice, the resin barrier Opaldam Green (Ultradent®) was applied in order to isolate the working field and to protect the gingiva, both of which are mandatory when using Icon. Fig. 3: To condition the surface, Icon Etch was applied for 2 minutes. The etching gel was removed with water spray for 30 seconds and the surface was dried. The etching step was repeated 4 times. Especially with fluorosis it is often necessary to repeat the etching step several times to gain sufficient access to the lesion body. Fig. 4: In the next treatment step Icon Dry was applied for 30 seconds. Immediately after the wetting with Icon Dry, the operator is given a preview of the masking effect. If the lesions do not diminish, the etching step should be repeated. After 30 seconds the surfaces were thoroughly dried with oil-free and water-free air.

Fig. 5

Fig. 6

Fig. 5: Next Icon Infiltrant was applied. It was allowed to set for 6 minutes because of severe fluorosis diagnosis. Excess material was removed with a cotton wad and dental floss before the infiltrant was light-cured for 40 s. This infiltrant step was repeated, letting the infiltrant set again for 3 minutes before excess removal and light-curing. Polishing was performed with Flairesse medium (DMG®) and Enamel Shiny Micerium polishing kit (Micerium s.r.l.). The fluorotic spots on both central front teeth are completely masked. Fig. 6: Clinical situation 3 months after Icon treatment. The situation is stable and the lesions on teeth 21 and 11 are masked completely.

Key learnings

- With fluorosis in particular it is often necessary to repeat the etching step several times to gain sufficient access to the lesion body.
- Icon Infiltrant can be set for 6 minutes in the case of severe fluorosis diagnosis.
- Iconinfiltration treatment can be also used for the permanent teeth in young children.

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Patient history or aetiology. A trauma or apical periodontitis in the primary tooth

Affected tooth/teeth. Usually one or several teeth. Associated lesions can often be found on opposite jaw

Localization. Mostly affects the facial surface (the side closer to the lips or cheek)

Border. Well-demarcated.
May also involve a quantitative defect associated with reduced localised thickness of enamel (enamel hypoplasia)

Traumatic hypomineralisation

Dental history and visual diagnosis

Traumatic hypomineralisation of a permanent tooth is a consequence of periodontal trauma affecting the deciduous teeth. Whatever the severity of this trauma, the appearance of sequelae is sporadic [1].

The prevalence of this hypomineralisation is estimated at 5.2%. This figure is not surprising, given that one third of children suffer a traumatic episode involving their deciduous teeth before the age of 5.

The close anatomical proximity that exists between the apexes of the anterior deciduous teeth and the germs of their permanent successors, which also display delayed calcification, explains this relationship.

Traumatic hypomineralisation can present a wide variety of clinical expressions differing in shape, outline, localisation and even colour. They are generally punctiform lesions situated on the incisal half of tooth crowns. They are often limited to one tooth, and asymmetrical with respect to the corresponding contralateral teeth. However, associated lesions can often be found on mandibular opponents.

The histopathology of traumatic hypomineralisation is similar to that of WS and fluorosis. It involves also sub-surface hypomineralisation under a relatively well-mineralised surface layer.

Either superficial or deep erosion-infiltration works very well in treating traumatic hypomineralisation. [2].

Dr Jean-Pierre Attal

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Case 3. 1

Treatment of traumatic hypomineralised teeth.

Dr Jean-Pierre Attal

Clinical case report

A 25-year-old woman wanted to mask the two lesions on the central incisors. The diagnosis is almost easy: MIH was excluded because there are no lesions on first molars; fluorosis and incipient caries are also excluded according to clinical expressions. In the end traumatic hypomineralisation was diagnosed. One hour of treatment is planned to treat the two lesions.

Fig. 1: Initial situation with two lesions due to trauma on teeth 11 and 21 (white lesion on 21 and slighly yellow on 11). The third incisal portion of teeth displays a high translucency of the edge. As the lesion appears relatively deep, we know that we need to infiltrate in depth. We therefore eliminate a very thin layer of enamel with the bur

Fig. 2: First application of Icon Etch

Fig. 3: After rinsing, drying and application of Icon Dry, we note a slight masking of the lesions. But not enough to infiltrate

Fig. 4: Second application of Icon Etch

Fig. 5: After rinsing and drying

Fig. 6: Icon Dry allows a partial masking of the lesion. This shows that ethanol can infiltrate the porous lesion. We know that Icon Infiltrant could infiltrate too

Fig. 7: After infiltration with Icon Infiltrant and light-curing. The masking is efficient

Fig. 8: A small amount of enamel composite is sufficient to compensate for the very small loss of enamel substance due to the combination of bur and acid erosion. The lesions are not visible anymore

Key learnings

- For deep traumatic hypomineralisation, you almost always have to perform deep infiltration. You therefore need to sandblast or drill.
- Never infiltrate the lesion unless Icon Dry shows a clear modification after the rinsing of Icon Etch.

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Case 3. 2

Non-invasive treatment of enamel hypomineralisations with Icon

Prof. Zafer Cehreli


Fig. 1


Fig. 2


Fig. 3

In daily practice, developmental enamel defects are being more frequently seen in young patients. The management of such enamel lesions depends on the type and severity of the defect, and minor lesions are often treated by bleaching, microabrasion or conservative resin-based restorations. Resin infiltration was originally developed for the non-invasive treatment of initial proximal carious lesions and post-orthodontic white spot lesions, but its aesthetic masking effect achieved by taking on the appearance of the surrounding enamel has introduced new possibilities for the non-invasive aesthetic management of a variety of developmental enamel defects, including enamel hypomineralisations. This is of particular importance because hypomineralised enamel is resistant to conventional acid etching, which may lead to poor micromechanical adhesion and subsequent microleakage when such lesions need to be treated with resin-based composites. On the other hand, microabrasion may lead to some tissue loss at the surface layer, which often needs to be restored with composite resin.

Icon can mask small, white developmental defects by infiltrating into the pores with a resin that has a refractive index close to that of the surrounding sound enamel. The masking effect is immediate, and in most cases dramatic. Aesthetic improvements are even observed in teeth with incomplete resin penetration. The Icon system utilises 15% hydrochloric acid to open the pores within the lesions, thereby facilitating penetration of the resin infiltrant. Even after repeated applications of hydrochloric acid, the enamel removed from the surface is almost negligible, resulting in a truly non-invasive, ultraconservative aesthetic treatment.

The following case is a typical example of small, shallow hypomineralisation lesions. The patient seeks aesthetics, while the parents demand a non-restorative solution. **Fig. 1:** A 9-year-old girl with hypomineralisation lesions on central and lateral incisors. The patient is more concerned with the lesions on central incisors. The parents do not prefer restorative treatment. **Fig. 2:** View of the lesions under a cross-polarisation filter, which eliminates highlights that mask the opacities, and thus provides a better appreciation of the borders of the lesions. **Fig. 3:** Isolation of affected teeth after cleaning of surfaces with fluoride-free pumice and rotary rubber cup at slow speed. Before placement of the rubber dam, the gingiva should be isolated with Vaseline to ensure protection. The borders of the lesions can be better appreciated after dehydration. Tooth no 11 has well defined borders, while 21 has diffuse hypomineralisations. The lesion on 11 appears to be deeper than its neighbour, suggesting that additional etching may be necessary. **Fig. 4:** The hydrochloric acid gel is applied to the lesions and allowed to sit for 2 minutes. **Fig. 5:** All tooth surfaces should be thoroughly washed with air-water spray for at least 30 s and the teeth should be dried meticulously with oil-free compressed air. **Fig. 6:** Icon Dry is absolute ethanol, and is applied to dry the pores within the lesions. Icon Dry has a second important function of providing a preview image of the final appearance after infiltration. To achieve best results, the ethanol should remain on the tooth surfaces for at least 30 seconds. Here the lesion on tooth 21 appears to be masked satisfactorily, while the lesion on 11 suggests that an additional etching step will be necessary. **Fig. 7:** This time, the Icon Etch is applied only to tooth 11 for 2 minutes. **Fig. 8:** Again, the tooth is rinsed for at least 30 seconds with air-water spray. **Fig. 9:** Dry with oil-free and water-free air. There is no visible change. However, a decision can only be made after the application of Icon Dry.


Fig. 4


Fig. 5


Fig. 6


Fig. 7


Fig. 8

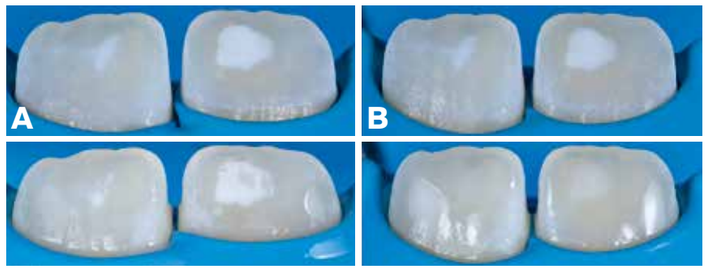

Fig. 9


Fig. 10


Fig. 11

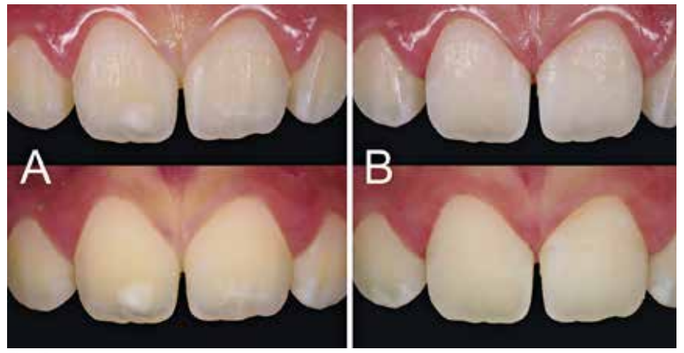

Fig. 12

Following a 30-second application of absolute ethanol, the lesion on tooth 11 appears to be masked well. The first (A) and second (B) rounds of Icon Dry applications are compared. For each step, the upper photo shows the dried lesion and the lower one shows the dramatic masking effect created by absolute ethanol. After two rounds of etching and drying, it is evident that an additional etching step will not be required. **Fig. 10:** Application of the Icon Infiltrant. An ample amount of Icon Infiltrant should be introduced onto the lesion site and should rest for 3 minutes with the operatory light turned off. Excess resin should be removed from the surface with gauze and the teeth should be exposed to curing light for 40 seconds each. Then the Icon Infiltrant should be applied as a second layer for at least 1 minute and subsequently light-cured as with the first layer. It is always beneficial to perform a final round of light-curing with the tooth surfaces covered with glycerine gel to prevent an oxygen-inhibited surface layer. **Fig. 11:** Excess resin should be gently removed using slow-speed discs or rubber cups, leaving a polished enamel surface. **Fig. 12:** Immediate post-operative view showing the total masking effect. Under cross-polarisation, the borders of the lesions are invisible and there is an excellent colour match. In this patient, the aesthetics was reestablished without the need to treat the laterals. A comparison of preoperative (A) and post-operative images (B) shows the masking effect achieved with a non-invasive treatment approach. For each image set, the upper photo shows the actual result, and the lower one shows the lesion under a cross-polarisation filter.

Resin-infiltration procedure for white spots

Dr Erik-Jan Muts

Fig. 1: Initial situation. A black background improves the contrast, but the white spots are still not clear. Britt is dissatisfied with the white spots on teeth 12, 11 and 21

Fig. 2: A cross-polarised photo of the initial situation with high colour intensity. The white spots instantly become clearly visible

White spots located on the front teeth can be very aesthetically unpleasant for the patient. To prevent the start of a restorative cycle, invasive treatment with composite or porcelain veneers is not advised. The removal of »healthy« enamel may weaken the tooth and may cause problems later on in life.
Using a resin-infiltration technique, the porosities inside the enamel, causing the white spots, can be infiltrated and filled with resin. In this way, we are able to treat white spots non-invasively nowadays with very good and long-lasting results.

Initial status
Britt (22 years old) was looking for minimally invasive treatment to remove the white spots on her front teeth (12, 11 and 21). I decided to take some pictures.
A cross-polarised picture with high colour intensity provides a lot of information because all the scattering from the flashlights is filtered away and differences between colours are more intense. After I had explained the situation and the possibilities with resin-infiltration techniques, Britt was convinced and went ahead with the treatment. There was no need for bleaching prior to the treatment.

Microabrasion
First of all a rubber dam (Optradam, Ivoclar Vivadent) is placed to achieve a clear and dry work field. A rubber dam is obligatory in these kinds of cases. Next we perform microabrasion using a microabrasive paste (Opalustre, Ultradent) to clean the surface and to start opening the porosities. It is applied three times for 60 seconds each (it is important to rinse thoroughly between each application). Instead of using a special microabrasive paste, the 15% hydrochloric acid (Icon Etch, DMG) can be mixed with some pumice and rubbed on with a special rubber cup using gentle force.

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 (sponge) Vestibular Tip for two minutes.

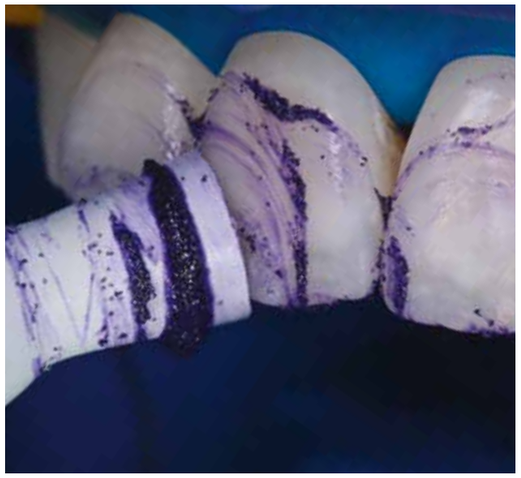

Fig. 3: Application of a microabrasive paste with a special rubber cup (Opalustre, Ultradent)

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: Applying 99% ethanol (Icon Dry, DMG) shows the masking of the porosities. One more etching procedure was performed after this result

After a lot of rinsing, the white spots become even more visible. This means the porosities are becoming more accessible. A check can be performed on the basis of ethanol absorption (Icon Dry DMG). Once the white spots disappear after ethanol is applied, the enamel is ready to be infiltrated. If they do not disappear, the etching procedure is repeated, with a maximum of five repetitions in total.

Infiltration
After the white spots have disappeared with the application of ethanol (Icon Dry, DMG), it is time to infiltrate with the methacrylate (Icon Infiltrant, DMG). Infiltration is also done with the special Vestibular Tip
Notice that there is no direct light on the working surface, since this may polarise the methacrylate particles, preventing them from infiltrating further. Capillary forces suck the methacrylate (Icon Infiltrant, DMG) into the enamel, filling up the porosities.

This may take a while and it is advised (DMG) to wait at least 3 minutes. In my experience it could infiltrate even further if left longer and I would advise waiting for at least 6 minutes. Polymerisation can be performed for 40 seconds after removing the excess with air. This infiltration procedure should be repeated for 1 to 2 minutes and light-cured as well. After light-curing, glycerine gel is applied and polymerised again for 40 seconds to remove the oxygen inhibition layer.

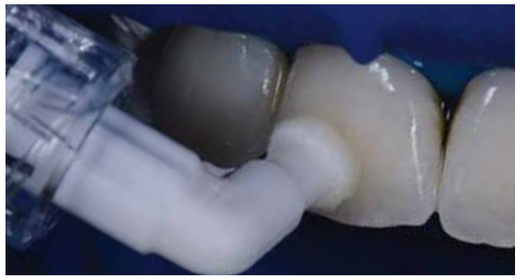

Fig. 7: Applying the methacrylate infiltrant (Icon Infiltrant, DMG) with the special (sponge) Vestibular Tip from DMG. Infiltrating the porosities with the infiltrant (Icon Infiltrant, DMG). Polymerisation with glycerine gel is performed to remove the surface oxygen inhibition layer

Fig. 8: Situation after polishing with rubbers (Brownie and Greenie, Shofu) and felt disc with aluminium oxide (Flexibuff with Enamelize, Cosmedent)

Fig. 9: Result immediately after treatment. The flashlight is scattered over the enamel surface, making it difficult to evaluate the result after treatment

Fig. 10: Cross-polarised photo of the initial result. There is clearly a lot of improvement compared with the initial situation. The white spots are gone!

Fig. 11: Result after 1 year seems to be very stable

Fig. 12: Cross-polarised record shows a very stable and satisfying result after 1 year of treatment

Polishing

After removal of the excess with scalers and dental floss, the surface is polished with rubbers, first using a brownie (Brownie, Shofu), followed by a greenie (Greenie, Shofu) and a felt disc (Flexibuff, Cosmedent) with aluminium oxide paste (Enamelize, Cosmedent).

Evaluation

Immediately after treatment the initial result is evaluated. The white spots on teeth 12, 11 and 21 have been completely removed and Britt is enormously happy. During and after treatment there was no sensitivity or adverse reaction of any kind. One year later I evaluated the treatment again and the result seems to be very stable. The resin-infiltration technique is a very useful and successful technique in aesthetically compromised white spot cases.

Key learnings

- With the help of Teflon it is easy to achieve isolation of neighbouring teeth.
- In the infiltration step, please make sure that there is no direct light on the working surface, since this may polarise the methacrylate particles, preventing them from infiltrating further.
- Capillary forces suck the nano-methacrylate (Icon Infiltrant, DMG) into the enamel, filling up the porosities. Please wait at least 3 min or even longer to make the infiltration process complete.

Minimally invasive approach in the treatment of enamel white spot lesions due to traumatic injuries of primary tooth: a clinical case

Dr Ali Salehi

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 more opaque areas of the white spots indicate deeper parts of the lesion that will require a deeper treatment.

Abstract

Hypomineralisation in the permanent dentition could be a consequence of traumatic injuries of primary teeth occurring during a child's early years of life while they were learning to walk and exploring the environment. This sequela is the consequence of periodontal trauma affecting the deciduous teeth [1, 2]. The proximity of these two dentitions explains why not only a severe infection but also a slight inflammation around the periapex of a primary tooth could disturb the maturation of the ameloblasts, leading to the appearance of traumatic hypomineralisation.

Diagnosis is not easy as the lesion can present a wide variety of clinical expressions differing in shape, outline, localisation and colour. They are generally punctiforms, located on the incisal third of tooth crowns, limited to one tooth and asymmetrical. Associated lesions can often be found on the opposite jaw, which is a pathognomonic sign of post-traumatic hypomineralisation.

Diagnosis is important because it will give an indication on how deep we need to go to reach the body of the lesion before we infiltrate. In this case the histology is similar to white spots and fluorosis as the lesion is usually close to a well-mineralised enamel surface layer [3], which is the result of post-eruptive ionic precipitation. In some cases, the lesion may be deeper. The severity of the opacity of the lesion can indicate whether we are facing a really deep lesion or a relative superficial one.

On a microscopic scale, like all white spot lesions, these lesions are enlargements of the interprismatic sheath creating the impression of gaps which are not present in healthy enamel. The presence of numerous gaps deflects the trajectory of light rays, which is responsible for the white appearance of the lesion. An erosion step before infiltration will attack the thin layer of well-mineralised enamel that acts like a barrier and make the lesion accessible for the infiltration [4]. Infiltration will then be possible in the whole lesion to fill the gaps. The infiltrant's reflection index is close to that of healthy enamel, so the light rays will keep the same trajectory as in normal enamel, and the white spots will disappear.

However, for post-traumatic hypomineralisation, the edges of the lesion can have acute or obtuse angles [3, 5].


Fig. 2


Fig. 3


Fig. 4

Fig. 2: Rubber dam placement after having chosen the colour of the composite that will be needed after the erosion-infiltration steps
Fig. 3: The depth of the lesions indicates a thicker well-mineralised 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 achieve a 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 along with the healthy enamel surrounding the white spots to optimise the result and limit the »edge effect« due to 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 satisfactory 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 satisfactory result with dramatic masking of the white lesions


Fig. 8

In the case of obtuse angles, like in white spots and fluorosis, the erosion stage is effective in achieving complete infiltration in the entire hypomineralised area and making the spot totally disappear.
In the case of acute angles, the infiltration could be incomplete on the margins, leaving the contours of the lesion still visible after treatment. We are able to eliminate the thin, relatively well-mineralised surface layer by erosion, but only the central part of the lesion will be accessible to the infiltrant, while on the edges of the lesion, erosion alone cannot remove the peripheral healthy enamel, which will make resin infiltration ineffective on the edges of the lesion. As a result, the centre of the spot disappears while a more or less homogeneous white outline remains. This result is sometimes more unsightly than the spot itself.

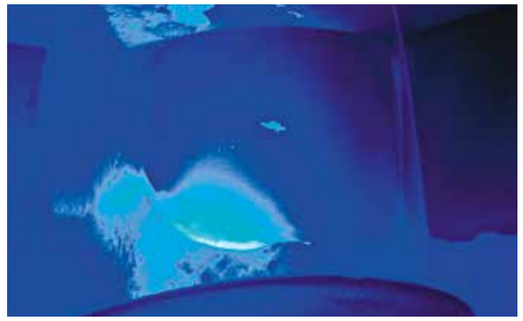
Fig. 9


Fig. 10

Fig. 8, 9 and 10: Apply the Icon Infiltrant for 3 min and then light-cure; 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

In order to improve the effectiveness of erosion-infiltration treatment in all situations of traumatic hypomineralisation, light sandblasting can be done to increase the peripheral erosion.

Conclusion

In order to perform a treatment that can balance the effectiveness and minimally invasive approach, a proper diagnosis of the lesion prior to any kinds of treatment is important. Depending on the aetiology of the lesion we can have some 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 the initial morphology at the end of the treatment.


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

Key learnings

- For post-traumatic hypomineralisation, the edges of the lesion can have acute or obtuse angles. In case of acute angles, the infiltration could be incomplete on the margins, leaving the contours of the lesion still visible after treatment.
- A proper diagnosis of the lesion prior to any kind of treatment is important. Depending on the aetiology of the lesion, we can have some idea of its shape and depth, and accordingly we can decide whether superficial or deeper erosion-infiltration treatment should be performed.
- The combination of sandblasting, Icon infiltration and enamel composite restoration can achieve good aesthetic results for traumatic white spot lesions.

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Case 3. 5

Deep infiltration for traumatic hypomineralisation: an aesthetic and conservative treatment

Dr Marie Clement

Fig. 1–2: Initial intra oral picture and initial polarised picture

In everyday practice, the dental surgeon, under increasing pressure from patients with aesthetic concerns, is more and more often called on to treat abnormalities in tooth colour.

The presence of a visible white area on the tooth surface is due solely to a defect in the enamel. This patient presented a deep traumatic hypomineralisation of a permanent tooth (Fig. 1–2). This is a consequence of periodontal trauma affecting the deciduous teeth. This may involve displacements of all kinds (concussion, subluxation, luxation, intrusion, extrusion, extraction). Traumatic hypomineralisations can present a wide variety of clinical expressions differing in colour, shape and outline. They are often limited to one tooth and sometimes associated lesions can be found on mandibular opponents. Medical history is not one of the leading criteria on account of its uncertain utility (it is difficult to remember a shock that occurred several years previously). It is the elective nature of traumatic hypomineralisations rather than their clinical presentation that provides the most useful diagnostic information [1]. So the diagnosis of traumatic hypomineralisation remains essentially diagnosis by exclusion (with fluorosis, white spots and MIH).

Fig. 3

Fig. 4

Fig. 5

Fig. 3–5: The first step after isolation with rubber dam placement is a prophylactic polishing. The deep cycle protocol is then to perform sandblasting with aluminium oxide, 27 microns (Fig. 3). Erosion with Icon Etch (15% HCl) 2 minutes (Fig. 4) Dehydration with Icon Dry (application of alcohol) (Fig. 5). At this stage we have to control if the spot is still present. If so, a second identical cycle is necessary [3]

Fig. 6

Fig. 7

Fig. 8

Fig. 6: The third times Icon Dry application (after 3 cycles). For our patient, three deep cycles were necessary: the optical change now concerns all lesions in totality and infiltration is possible. **Fig. 7:** Infiltration is performed with Icon Infiltrant for 3 minutes [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, glycerine 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 working of surface texture with different brushes. A last light-curing is necessary with glycerine to avoid the inhibited layer resulting oxygen

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

Fig. 10: Final polarised picture

The histopathology of traumatic hypomineralisation involves subsurface hypomineralisation under a relatively well-mineralised 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 hypomineralisation 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: deep infiltration [2].

A deep infiltration treatment is proposed to our patient. Before the treatment the patient is informed that a composite resin will probably be used 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 lesion is deep.

Key learnings

- Traumatic hypomineralisation of a permanent tooth is a consequence of periodontal trauma affecting the deciduous teeth.
- The diagnosis of traumatic hypomineralisation remains essentially diagnosis by exclusion (with fluorosis, white spots and MIH).
- A last light-curing is performed with glycerine to avoid the inhibited layer resulting from oxygen.

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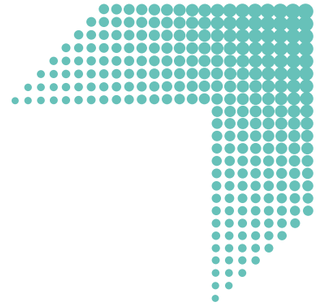
Patient history or aetiology. Unknown, non-specific

Affected tooth/teeth. One to four affected permanent molars and the associated incisors

Localisation. Affected first permanent incisors with MIH are asymmetrical. Usually limited to the incisal or cuspal third of the crown, rarely involving the cervical third

Border. Well-demarcated, a qualitative defect affecting enamel translucency. No changes to the enamel thickness

colour. Whitish-cream or yellow-brown. The intact enamel surface is hard, smooth and often hypermineralised following post-eruptive maturation, the subsurface enamel is soft and porous [3, 4]



Molar incisor hypomineralisation (MIH)

Dental history and visual diagnosis

MIH is a condition related to demarcated hypomineralised lesions affecting at least one permanent first molar and often the permanent incisors. Other teeth can be affected by demarcated hypomineralised lesions (such as the second primary molar). However, they are not included in the MIH definition, but it should be possible to treat them in a similar manner.

MIH affects approximately 14% of the population [1], with approximately one third being severely affected. Diagnosis is based on detection of a demarcated opaque lesion of the enamel located in the occlusal 2/3 of the crown (the gingival third is not affected) [2]. The colour varies from opaque white to yellow/brown, and severity of mineral loss normally increases with a darker colour.

With more severe lesions, there may be post-eruptive breakdown (PEB) or loss of enamel, and this may be associated with a carious lesion.

MIH-type demarcated lesions differ from other developmental defects such as hypoplasia and fluorosis. Hypoplasia is a quantitative defect – that is, there is developmentally thin enamel, often in a horizontal linear pattern or pitting. Fluorosis is a diffuse hypomineralised lesion, corresponding to the developmental lines of the tooth development, with indistinct definition between sound and fluorosed enamel.

Until now, MIH has not been indicated for the infiltration treatment with Icon. Nevertheless, infiltration of MIH lesions often leads to significant improvements of aesthetics and has a positive impact of patient's quality of life. In this chapter various MIH cases with different approaches and successes are shown.

Prof. David J. Manton

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Case 4.1

A new concept for treating enamel opacities

Prof. Nabiha Douki Zbidi, Dr Omar Marouane, Dr Fadwa Chtioui

Fig. 1: Initial view of a lesion on the upper right lateral incisor

Fig. 2

The introduction of the resin infiltration technique has completely redefined the way we treat enamel hypomineralisation. However, this procedure remains a depth-dependent technique [1]. Given that the success of the infiltration technique entirely depends on the lesion's topography, a new classification of enamel hypomineralization, based entirely on the lesion's depth, has been set forth. The optical properties of the enamel served as the basis for this classification, which includes a precise, but simple, description of the lesion in daylight conditions as well as under transillumination, so that the clinical data collected can ultimately be matched with the corresponding lesion topography.

This classification regroups three major types of enamel opacities: superficial, mixed and deep lesions. Each category has specific clinical features in relation with the topography of the lesion and the proper treatment approach will be then adopted accordingly. Bearing in mind that superficial lesions represent the easiest category for achieving a favourable treatment outcome, the idea behind the proposed treatment concept implies the transformation of mixed and deep lesions into superficial ones using abrasive procedures before proceeding with their infiltration [2]. This clinical case report describes a suggested treatment of a deep lesion affecting a lateral maxillary incisor related to MIH based on transillumination, focalisation and lesion transformation to achieve a good aesthetic result.

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 2: Lateral incisor showing an ivory-white opacity melded in sound enamel tissue located in the incisal third. Note the presence of the stained opacity affecting the first right lower molar confirming the MIH diagnosis. **Fig. 3:** Under transillumination, the lesion appears opaque with blurry edges showing an indistinct interface between the enamel opacity and sound enamel. **Fig. 4:** Lesion focalisation using a light-cured resin protective barrier. The aim of this procedure is to be more conservative during abrasive and erosive steps. A mild mutilation of the enamel layer covering the lesion using an abrasive disc. This step was assessed under visual examination and transillumination until the lesion is exposed almost entirely and superficial features are perceived. **Fig. 5:** The exposed hypomineralised enamel was etched for 120 s using Icon Etch (15% HCl). **Fig. 6:** Aspect of the lesion within the reflection of incident light following abrasive and erosive steps. Note the transformation of the opacity from an ivory-white to an intensely white lesion.

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 7: Aspect of the lesion under transillumination after abrasive and erosive steps. The lesion edges are now well demarcated, suggesting the transformation into a more superficial lesion. **Fig. 8:** Dehydration using Icon Dry. **Fig. 9:** Infiltration is performed using Icon Infiltrant. The lesion should be infiltrated for at least 3 minutes until complete saturation and no further infiltration seems to be possible. A quick control (to avoid light-curing) under transillumination is recommended during this step to assess the degree of infiltration. **Fig. 10 and 11:** The features of the lesion within light reflection and transillumination following the infiltration procedure show a partial infiltration with an almost complete disappearance of the opacity, which remains only at the margins. In cases where the lesion is not completely infiltrated, it is highly recommended to wait for the enamel rehydration in order to properly assess the final aesthetic outcome of the infiltration [3]. **Fig. 12:** Two weeks later, at the next appointment, the appearance of the lesion shows no improvements. Accordingly, the etching, drying and lesion infiltration were all repeated exactly as performed in the first session. **Fig. 13 and 14:** Aspect of the lesion under incident light and transillumination after a second session of resin infiltration procedure showing the complete disappearance of the opacity as well as of the halo effect. **Fig. 15:** Final result.

Key learnings

- In transillumination and with the reflection of incident light, the aspect of the opacity gives topographic information regarding the lesion's depth. This actually makes it possible to set the treatment steps accordingly.
- The newly suggested concept provides direct visual assistance to the practitioner during the lesion transformation and after infiltration and helps with assessing the treatment progress by providing a more controllable and reproducible outcome.
- In the case of partial infiltration, re-intervention is possible to infiltrate the remaining un-infiltrated area.

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Case 4. 2

Deep infiltration of MIH lesions: the use of transillumination as a diagnostic tool

Associate Prof. Carlos Rocha Gomes Torres, Associate Prof. Alessandra Bühler Borges

Fig. 1: Patient with main lesions in upper incisors, left canine and first upper molars, characterising MIH. The lesions on mesial surface of molars has already been restored with composite

The aesthetic treatment of white lesions in anterior teeth is a frequent challenge for dentists in the clinical practice. Different aetiologies may change the enamel mineral structure and interfere with its interaction with the environmental incident light. Due to pathological changes that affect the enamel refractive index, the light undergoes deflection and reflection inside the lesion, creating an optical maze which is over-luminous and responsible for the whitish aspect on the affected areas [1]. The enamel caries lesion is one of the most common problems, as a result of the hydroxyapatite demineralisation caused by acids from the bacterial biofilm, associated with high consumption of fermentable carbohydrate. Even with the reduction of the caries disease activity, the arrested deep lesions can remain visible, impairing the aesthetics of the smile. Since the 1970s, attempts to infiltrate initial enamel caries have been reported [2, 3], but it was not until the late 2000s that the technique was improved and a commercial product (Icon, DMG) was developed.

At this time, the resinous infiltration technique was mainly directed towards arresting the approximal lesions progression on posterior teeth, filling the lesion body with resinous monomers [4, 5, 6]. The treatment is based on erosion of the external surface zone of the lesion with hydrochloric acid gel, followed by washing, dehydration with absolute ethanol, infiltration with resinous monomers and light-curing. However, since the infiltrant formulation has a refractive index close to that of sound enamel, a colour-masking effect was observed, stimulating its use as an aesthetic treatment on anterior teeth [7, 8]. Due to the histological structural similarities between carious white spot lesions and hypomineralised fluorotic white lesions, the resinous infiltration procedure also produced excellent clinical results on those cases [9].

The success of the infiltration protocol on the treatment of caries and fluorotic lesions stimulated the researchers to test this procedure in other kinds of developmental white lesions, such as traumatic lesions and molar incisor hypomineralisation (MIH). MIH lesions are enamel defects that occur due to depressed activity of the enamel-forming ameloblasts. This condition has a multifactorial aetiology such as preterm birth, low birth weight, respiratory diseases, poor general health or systemic conditions in the first three years of life [10, 11]. The clinical expression of the disease implies the presence of qualitative enamel defects in at least one of the four first permanent molars, possibly associated with lesions on the permanent incisors.

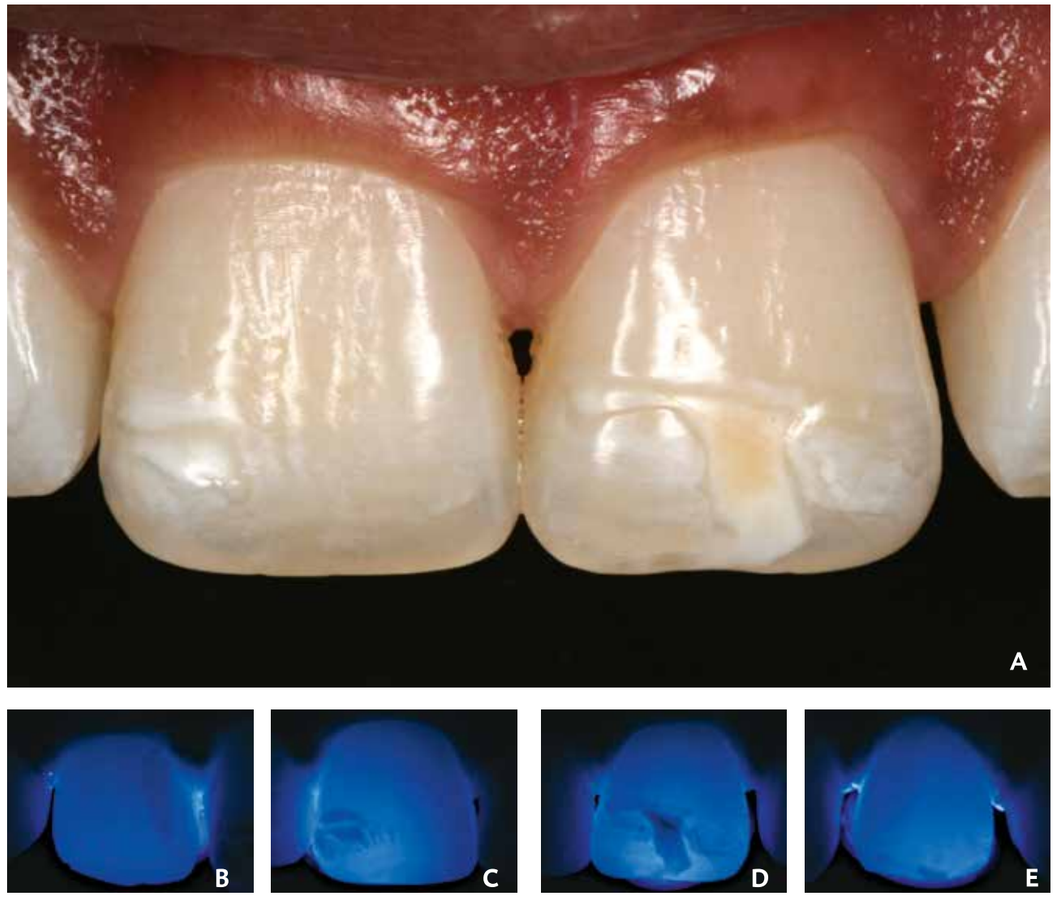


Fig. 2 A–E: Transillumination of the main lesions in the upper. It can be observed that the main lesion in the left central incisor (Fig. 2 D) presented a black central area when transilluminated, indicating that it was deeper than the lesions in the other incisors (Fig. 2 B, C and E). Based on this, the deep infiltration technique was used only on the left central incisor. Besides the main lesions, small whitish areas were spread over the whole surfaces of the anterior teeth

Sometimes, the cusps of the canines and the second molars are also involved [1].

However, attempts to infiltrate the MIH lesions with the same technique used for caries and fluorosis did not produce acceptable aesthetic results. A white halo or edge effect was observed around the lesion after the infiltration, indicating improper penetration of the resinous monomers at the borders [12]. This occurs because the internal lesion margins form a different angle with the external tooth surface than the caries and fluorotic ones. In MIH, the lesions' margins form an acute angle with the external surface, impairing the monomer penetration at this area, while for the caries and fluorosis lesions the borders form an obtuse angle with the surface, allowing uniform resinous infiltration [1]. In addition, in deep MIH lesions, the defective enamel is sometimes covered by a layer of intact enamel, which cannot be removed by the erosive effect of the hydrochloric acid alone, completely preventing the interaction between the infiltrant and the lesion body [1].

In attempt to overcome this problem, Attalet al. [12] proposed the deep infiltration protocol, in which the external lesion surface should first be removed using mechanical abrasion with aluminium oxide sandblast or a rotary diamond bur. This procedure grants access to the lesion body, allowing penetration of the resinous monomers. In addition, the border area can be gently removed, preventing the halo effect after the infiltration. The area is then covered with a composite restoration. Even after a small superficial enamel tissue removal, the infiltration of the lesion body can increase the translucency of the subjacent affected enamel, providing a better background for the composite restoration. Without a previous infiltration, the opaque background prevents the applied composite layer from masking the whitish area correctly, making deeper removal of the affected tissue necessary in order to provide adequate results. Therefore, although the deep infiltration procedure demands some tissue removal, it could be considered a more conservative approach, since it eliminates the necessity of a deep cavity preparation in order to obtain an acceptable aesthetic outcome.

Fig. 3: As a composite would be necessary to cover the deep infiltrated area, shade selection was performed as the first step

A

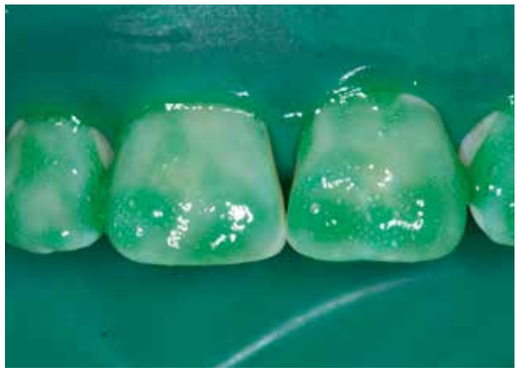
B

Fig. 4 A–B: A small preparation was performed in the deep lesion in order to provide access to the lesion body and remove the external enamel on the borders.
A round diamond bur was used to remove only a minimal amount of tissue

However, the correct diagnosis and clinical decision as to when to indicate the regular superficial infiltration and when to use the deep infiltration technique remains a clinical challenge. In order to help the clinician to make this decision, the transillumination technique can be very useful. This procedure was originally developed for diagnosis of caries lesions mainly in the proximal surface of posterior and anterior teeth. It is performed by placing a high output light source, such as a blue light-curing unit, on the lingual surface of the suspected tooth, allowing the light to pass through its structure and reach the labial surface, which can be evaluated by the dentist. On a sound tooth, due to the relatively homogeneous structure of enamel and dentine, the light is transmitted normally and a light blue aspect is noticed in the whole crown. However, in the presence of caries or a hypomineralised lesion, the area can appear dark blue or completely black, indicating the reduction or complete blockage of the light transmission through the tooth, depending on the lesion dimensions. Our personal experience with using the transillumination technique on MIH lesions has shown that when a light blue aspect is noticed in the baseline analysis of the clinical case, the lesion is likely to be shallow, and the regular superficial infiltration can be attempted first. However, when dark blue or black areas are observed in the centre of the lesion, it is to be considered deep, and the deep infiltration technique should be performed from the beginning of the treatment.

Next, a clinical case of colour masking of MIH lesions is presented, in which some lesions were infiltrated with the superficial technique, while others received the deep infiltration procedure associated with the composite restoration.

A



B

Fig. 5 A–B: After that, etching with hydrochloric acid gel was performed only over the main lesions, in order to remove the external surface of the shallow ones, and increase the permeability of the bur-opened deep ones. The acid (Icon Etch, DMG) was applied for 6 minutes over the main lesions, since shorter times are usually insufficient in those cases. Then the whole surface was additionally etched for 2 minutes, in order to etch the small lesions spread over the teeth surfaces.

A

B

C

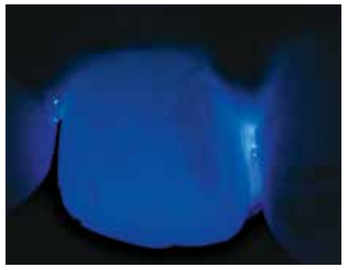
D

Fig. 6 A–D: The gel was washed and the surfaces dried with an air stream, followed by the ethanol application (Icon Dry, DMG). Besides dehydrating the enamel, the ethanol penetration can also provide a preview of the infiltrant masking effect [13]. Although the refractive index of ethanol is lower than that of the infiltrant, if some masking effect is observed after its application, a more favourable masking will be provided by the resinous infiltrant. However, if the aspect is not changed after the ethanol application, no change is likely to be observed after using the infiltrant, indicating that an additional etching or wear with the bur must be performed. Comparison between after etching and drying (A, B) and after the ethanol application (C, D).

A

B

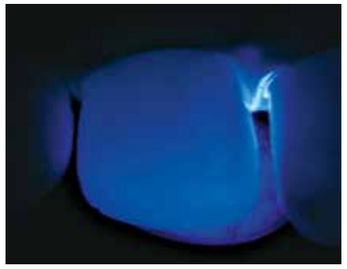
Fig. 7 A–B: After that, the surface was dried with air and the resinous infiltrant (Icon Infiltrant, DMG) was applied over the labial surface of all teeth, remaining undisturbed for 3 min. The excess was removed with an air stream and the light-curing was performed for 40 s on each teeth. Then the infiltrant was applied again and left on the surface for 1 minute. The excess was removed and the light-curing was performed



A

B

C



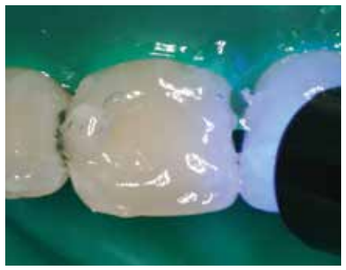
D

E

F

Fig. 8 A–F: The transillumination procedure was repeated after the infiltration, showing a significant increase in the light transmission. The dark areas of the deep lesion in the left central incisor became lighter (Fig. 8 C and 8 F), while the lesion in the right lateral incisor became even more translucent than at the baseline (Fig. 8 A and 8 D)

A



B

C

D

Fig. 9 A–D: Next, the deep infiltrated lesions were restored with composite (Fig. 9 A). A layer of glycerine gel was applied over the whole infiltrated teeth surface in order to eliminate the environmental oxygen, which can inhibit curing of the external infiltrated layer, providing a better conversion degree of the monomers in polymers (Fig. 9 B). After that, the surface was polished first with abrasive discs and then with felt discs and polishing paste

A

B

Fig. 10 A–B: Post-treatment results

Key learnings

- In the deep infiltration protocol, the external lesion surface should first be removed using mechanical abrasion with aluminium oxide sandblast or a rotary diamond bur.
- The transillumination technique can be very useful for identifying the depth of the lesion. When a light and uniform blue aspect is observed in the baseline analysis of the clinical case, the lesion is likely to be shallow, and regular superficial infiltration can be attempted first. However, when dark blue or black areas are observed in the centre of the lesion, it is considered deep, and the deep infiltration technique should be performed.
- The aesthetic treatments of MIH may be combined with the superficial infiltration technique and the deep infiltration procedure followed by the composite restoration.

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Microinvasive aesthetic treatment for MIH lesions

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Fig. 1: Initial aspect of the lesion

Molar incisor hypomineralisation (MIH) lesions represent a challenge for paediatric dentistry, with increasing prevalence [1]. The lesions are characterised by enamel with deficiency in minerals, rich in albumin and with normal content of amelogenin [2, 3]. Its aetiology is still unknown but it is believed that it is caused by disturbances during the enamel mineralisation stage [4].

Fig. 2: Hypomineralisation in the maxillary molar associated with MIH

Fig. 3: Closer view of the white-yellow lesion in the enamel

The clinical aspects of the lesion are changes in the enamel colour and translucency, resulting in brown-yellow or white asymmetrical spots mainly in incisors and first molars [4]. Histologically, these lesions are characterised by disorganised crystals and larger interprismatic spaces, with lower mineral density [5–7].

Attempts to mineralise the molars and incisor spots with fluoride varnishes, similarly to what is indicated for treatment of white spot lesions (WSL), have been made without success [8–10]. Recently, the infiltration of low-viscosity resin (Icon, DMG, Hamburg, Germany) became a minimally invasive option for the treatment of WSL [11–14]. This treatment aims to fill the porous interprismatic spaces inside the lesion [11, 13, 15] with the resin infiltration [14]. The infiltrant presents a similar light refraction index to sound enamel [16], and therefore creates a masking effect [14, 17].

The efficacy of resin infiltration for superficial WSL has been shown previously [12, 13, 18–20]. Since favourable aesthetic outcomes were obtained, the technique was also used in enamel developmental defect lesions, such as fluorosis, traumatic hypomineralisation, and MIH [21, 22].

Unlike caries and fluorosis lesions, which present an external surface larger than the internal one, the MIH lesions originate at the dentine-enamel junction and extend into the enamel. Therefore, the erosive effect of applying HCl to the surface before infiltration does not enable the »ceiling« of the lesion to be reached [21].

As the infiltration takes places on superficial healthy enamel and the anatomy of the MIH lesion presents an internal surface larger than the external one, it does not produce a favourable optical effect, explaining why treatments of MIH lesions by erosion/infiltration are not successful. Thus, in MIH lesions, the requirements for deep infiltration are preferable [21]. In deep infiltration, the superficial portion of enamel must be slightly removed in order to reach the sub-surface enamel portion where the MIH lesion is present.

Fig. 4: In the first step, prophylaxis was performed and the labial surface of the affected enamel was slightly prepared with a diamond bur to expose the top surface of the lesion and allow access to the resin infiltrant inside the affected region

Fig. 5: After partial removal of affected enamel, (note that the discoloured inner enamel remains), resin infiltration technique was performed using Icon Infiltrant for smooth surfaces kit (DMG, Hamburg, Germany). The rubber dam isolation was applied

Fig. 6: The surface was eroded with 15% HCl gel (Icon Etch) for 2 minutes. After that, the acid was fully washed with air/water spray and dried

Fig. 7: In order to completely remove water from microporosities, the lesion surface was given an application of 99% ethanol (Icon Dry) for 30 s, and again air-dried. After Icon Dry application, when the lesion becomes invisible or is reduced in intensity, this means the etched lesion is ready to be infiltrated properly. When no change occurs, the preparation can be extended in depth, and/or a new etching step is performed, until some masking with Icon Dry is observed. The total depth of enamel removal in this clinical case was about 0.5 mm, and the acid was applied for 6 minutes (three applications of 2 minutes). This progressive preparation is performed to allow the intervention to be as minimally invasive as possible

Fig. 8: Finally, the Icon Infiltrant was applied in two steps. The first application was performed for 5 minutes, with the surface protected from ambient light with an opaque screen

Fig. 9: Then excess was removed from the surface with a blow of air, and light-curing was performed for 40 s. The infiltrant was applied a second time, for 1 minute, and again light-cured for 40 s

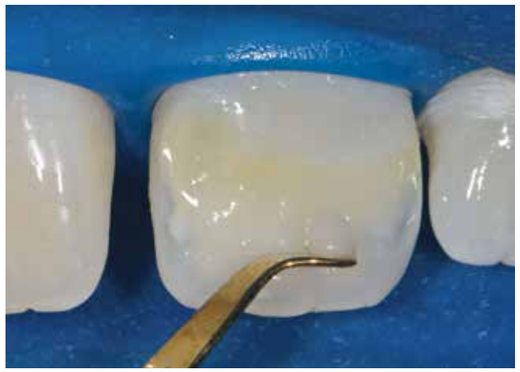

Fig. 10: Then composite resin was applied (Filtek XTE Supreme, 3M ESPE, St Paul, MN, USA) in increments. No separated bonding agent was applied, since the Icon Infiltrant is itself able to facilitate adhesion to the tooth structure [23]. Each increment was light-cured for 40 s. Finishing and polishing procedures were performed (Soflex discs, 3M ESPE)

Fig. 11: A closer look at the immediate outcome for the teeth

Case report

An 11-year-old female patient presented a yellow-white lesion in the left maxillary central incisor (Fig. 1), and also affected maxillary first molars, presenting enamel breakdown and cavities (Fig. 2). The pronounced discoloured lesion at the front incisor seriously compromised the patient's smile aaesthetics (Fig. 3).

The patient reported that the tooth erupted with the spot, and that she had never experienced any kind of dental trauma. The diagnosis of fluorosis was also discarded due to the asymmetrical distribution of discolourations. Since the defects affected both molars and incisors, MIH was diagnosed.

The proposed treatment option was deep resin infiltration combined with composite restoration.

Summary

Molar incisor hypomineralisation is a growing concern in paediatric dentistry. The unsatisfactory aaesthetics promoted by the white spots lesion in anterior teeth is usually the main reason patients look for treatment. Minimal intervention is required for these cases, and deep resin infiltration may be a viable option.

Key learnings

- The MIH lesions originate at the dentine-enamel junction and extend into the enamel. Therefore, the anatomy of the MIH lesion presents an internal surface larger than the external one.
- As the infiltration takes places on superficial enamel and the anatomy of the MIH lesion, it does not produce a favourable optical effect, explaining why treatments of MIH lesions by erosion/infiltration are not successful. Thus, in MIH lesions, deep infiltration needs to be performed.
- In deep infiltration, the superficial portion of enamel must be slightly removed in order to reach the subsurface enamel portion where the MIH lesion is present.

Fig. 12: Final outcome after one month

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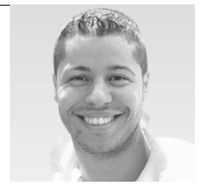

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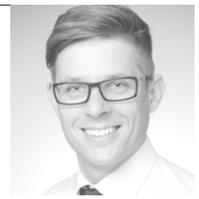

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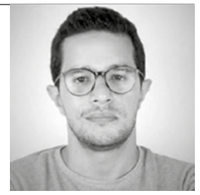

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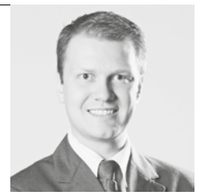


1999–2003	Dental School at the University of Passo Fundo, Brazil
2004–2006	Specialisation and MSc in Operative Dentistry at the Federal University of Santa Catarina, Brazil
2006–2009	PhD in Operative Dentistry at the Federal University of Santa Catarina, Brazil
2008	Visiting Researcher at the Prosthodontics Department of the University of Munich, Germany
2012–2015	PhD in Medical Sciences (Cariology/Dentistry) at the Radboud University Nijmegen, Netherlands
2009–2018	Adjunct Professor of Operative Dentistry at the University of Brasília, Brazil
Since 2018	Associate Professor of Operative Dentistry at the University of Brasília, Brazil

Main areas of work: Preventive and restorative dentistry focused on minimum intervention, adhesion to enamel and dentine, tooth bleaching, resin infiltration, composite resins

Contact: Prof. Leandro Augusto Hilgert, University of Brasília (UnB), Department of Operative Dentistry, Campus Darcy Ribeiro, 70910-900 – Asa Norte – Brasília, Brazil

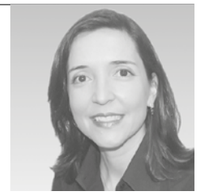
Marília Bizinoto Silva Duarte MSc – University of Brasília, Brazil

2008–2012	Dental School at the University of Brasília, Brazil
2013–2014	MSc in Health Sciences (Dentistry) at the University of Brasília, Brazil
Since 2016	Lecturer of Operative Dentistry at the University of Brasília, Brazil
Since 2016	PhD candidate in Health Sciences (Dentistry) at the University of Brasília, Brazil
Since 2018	Dentist of the public health system of the federal district, Brazil

Main areas of work: Resin infiltration, enamel developmental defects, preventive and restorative dentistry focused on minimum intervention

Contact: Marilia Bizinoto Silva Duarte MSc, University of Brasília (UnB), Department of Operative Dentistry, Campus Darcy Ribeiro, 70910-900 – Asa Norte – Brasília, Brazil

Prof. Vera Mendes Soviero – Universidade do Estado do Rio de Janeiro and Faculdade Arthur Sá Earp Neto, Brazil



1991	Graduation in Dentistry at Universidade do Estado do Rio de Janeiro, Brazil
1994	Master's degree at Universidade Federal do Rio de Janeiro, Brazil
1997	PhD degree at Universidade Federal do Rio de Janeiro, Brazil
Since 1999	Associate professor at Universidade do Estado do Rio de Janeiro, Brazil
Since 2015	Dean of the Dental School at Faculdade Arthur Sá Earp Neto, Brazil

Main areas of work: Clinical studies on cariology and enamel defects

Contact: Prof. Vera Mendes Soviero, Universidade do Estado do Rio de Janeiro, Av. 28 de Setembro 157 – 2o andar, 20551-030 Rio de Janeiro, Brazil

Prof. Neeraj Gugnani – DAV (C) Dental College, Haryana, India

1991–1996	BDS study at DAV (C) Dental College Yamunanagar
1997–2000	MDS study in Pediatric and Preventive Dentistry at King George's Medical College, Lucknow
April 2000	Faculty member at DAV (C) Dental College Yamunanagar and since 2008 professor at the same institute
2009	Joined as Commonwealth Scholar at Dental Health Unit, University of Manchester, UK, for research training in the field of dental caries, especially early caries detection and management
2011	Awarded ORCA travel fellow award for research proposal regarding management of white spot lesions using resin infiltration and other non-invasive strategies
2012–2014	Completed MSc in Clinical Trials (with Distinction) at London School of Hygiene and Tropical Medicine, University of London, UK

Main areas of work: Caries detection and management including caries risk assessment, minimally invasive dentistry, community level prevention of caries, dental traumatology and restoration, paediatric dentistry, conducting phase III and IV clinical trials, establishing academic and corporate partnerships, clinical teaching and training for effective research methodologies and systematic reviews

Contact: Prof. Neeraj Gugnani, DAV (C)Dental college, Department of Pedodontics & PCD, Yamuna Nagar 135001, Haryana, India

Dr Arzu Tuna – myveneers, Cologne, Germany

1990–1997	Dentistry studies at the University of Cologne
1998–2012	Assistant professor at the Department of Operative Dentistry and Periodontology, University of Cologne
2002	Graduation to Dr med. dent.
Since 2012	Private practice Attendorn with Dr Umut Baysal
Since 2016	Private practice myveneers in Cologne, Germany, with Dr Umut Baysal
2017	Founding of MYV Smileclub

Main areas of work: Paediatric dentistry, aesthetic dentistry, aligner orthodontics

Dr Arzu Tuna, Praxis am Nordwall, Nordwall 2, 57439 Attendorn, Germany

Dr Jean-Pierre Attal – University of Paris Descartes, France

1983–1988	Dentistry studies at the University of Paris Descartes
1991–1995	Assistant professor at the Department of Dental Materials (Paris Descartes)
1995	PhD directed by Pr Michel Degrange
Since 1997	Senior lecturer
Since 2008	Accreditation to supervise research
Since 2015	Director of the dental materials lab URB2i (EA 4462)
Since 2015	President of the French Society of Biomaterials (SFBD)
Since 2016	Editor-in-chief of the Biomaterials Clinic Journal, Director of a Master in Biomaterials Engeneering (Paris Descartes), private practice from 1990 to date in Paris

Main areas of work: Adhesion to calcified tissues, glass ionomer cements, CAD-CAM materials, dental bleaching and resin infiltration

Contact: Dr Jean-Pierre Attal, Université Paris Descartes, 9, boulevard Arago, 75013 Paris, France

Associate Prof. Carlos Rocha Gomes Torres – Sao Paulo State University – UNESP, Brazil

1992–1995	Undergraduate studies at Sao Jose dos Campos School of Dentistry, Sao Paulo State University – UNESP
1996–2002	Private practice in Sao Paulo State
1999–2002	PhD degree in Operative Dentistry at Sao Paulo State University – UNESP
2002–2013	Doctoral assistant professor at the Department of Restorative Dentistry, Sao Paulo State University – UNESP
2009	Postdoctoral researcher at the University of Zurich – Switzerland
2013	Habilitation in Operative Dentistry at Sao Paulo State University – UNESP
Since 2013	Associate professor at the Department of Restorative Dentistry, Sao Paulo State University – UNESP

Main areas of work: Aesthetic treatments, dental bleaching, caries, dental erosion, adhesives, composites

Contact: Prof. Carlos Rocha Gomes Torres, Universidade Estadual Paulista – UNESP, Faculdade de Odontologia de Sao José dos Campos, Av. Eng. Franicsco José Longo, 777, Jd. Sao Dimas, Sao José dos Campos – Sao Paulo, Brazil

Prof. Zafer Cehreli – Hacettepe University, Ankara, Turkey

Professor of Paediatric Dentistry at Hacettepe University

Professor of Paediatric Dentistry at Louisiana State University Health Sciences Center

Chair, Education Committee, International Association of Dental Traumatology

Main areas of work: Minimally invasive restorative dentistry, paediatric endodontics, dental traumatology, biocompatibility and biomechanical testing

Contact: Prof. Zafer Cehreli, Hacettepe Üniversitesi, Diş Hekimliği Fakültesi, Çocuk Ve Ergen Dişhekimi, 06100 Sıhhiye Ankara, Turkey

Prof. David J. Manton – University of Melbourne, Melbourne, Australia

1984	Graduated BDSc at the University of Melbourne
1984–1991	General practice
1991–1993	MDSc in Paediatric Dentistry
1994–1996	Dental Adviser to Commonwealth Department of Human Services
2002–2006	Lecturer at the University of Melbourne
Since 2006	Elsdon Storey Chair of Child Dental Health and Head of the section of Growth and Development at The University of Melbourne

Main areas of work: All aspects of paediatric dentistry, enamel de- and remineralisation, teledentistry and MIH

Contact: Prof. David J. Manton, The University of Melbourne, Faculty of Medicine, Dentistry & Health Sciences, Room 5.103 | Level 5, 720 Swanston St Victoria 3010 Australia

Dr Richard Johannes Wierichs – RWTH Aachen University, Aachen, Germany

2006–2011	Dentistry studies at the University of Bonn (Rheinische Friedrich-Wilhelms-Universität Bonn), Germany
2012	Graduation to Dr med. dent. at the University of Bonn (Rheinische Friedrich-Wilhelms-Universität Bonn), Germany
2012	Private practice in Neuwied, Germany
2012–2016	Assistant professor at the Department of Operative Dentistry, Periodontology and Preventive Dentistry, RWTH Aachen University, Aachen, Germany
Since 2016	Assistant professor and senior physician at the Department of Operative Dentistry, Periodontology and Preventive Dentistry, RWTH Aachen University, Aachen, Germany
Since 2017	Scholarship holder of the medical faculty at the Department of Biohybrid & Medical Textiles, Institute of Applied Medical Engineering, RWTH Aachen University, Aachen, Germany

Main areas of work: Non-/microinvasive therapies of caries, root caries, de-/remineralisation of dental hard tissue, antibacterial therapy of dental hard tissue, healthcare research

Contact: Dr Richard Johannes Wierichs, Rheinisch-Westfälische Technische Hochschule Aachen (RWTH), Klinik für Zahnerhaltung, Parodontologie und Präventive Zahnheilkunde, Pauwelsstraße 30, 52074 Aachen, Germany

Dr Carla Cohn – Kids Dental and Western Surgical Centre Winnipeg, Manitoba, Canada

1984–1987	University of Manitoba Faculty of Sciences undergraduate programme
1987–1991	University of Manitoba Faculty of Dentistry
1991	Graduated Faculty of Dentistry with DMD (Doctor of Dental Medicine)
1991–1992	Health Sciences Centre Children's Hospital Dental Internship
1992	Certificate of Internship of Children's Dentistry
Since 1992	Part-time clinical instructor University of Manitoba Faculty of Dentistry
Since 1992	Private dental practice Kids Dental and Western Surgical Centre
Since 2009	Key opinion leader / lecturer

Main areas of work: Paediatric dentistry, lecturer in »paediatric dentistry for the general practitioner«

Contact: Dr Carla Cohn, Kids Dental 128-2025 Corydon Avenue Winnipeg Manitoba Canada R3P 0N5

Associate Prof. Giuseppe Allocca – University of Milan, Italy

2000–2001	Studies of Pharmacy at the University of Milan
2001–2003	Studies of Dental Hygiene at Medical School – University of Milan
2004	Graduated – Enabling of Dental Hygiene at Medical School – University of Milan
Since 2004	Private practice in Milan – Lodi – Bergamo, Italy
2014–2016	Professor a/c of Applied Medical Technical Sciences – Department of Operative Dentistry – University of Milan
Since 2015	Supervisor for courses on Hard Tissues – Periodontology and Preventive Dentistry
2014–2018	Professor a/c of Internship (Tirocinio clinico) – Department of Operative Dentistry – University of Milan

Main areas of work: Microinvasive therapies of caries, root caries, fluorosis and MIH, remineralisation of dental hard tissue, antibacterial therapy of dental hard tissue, dental aesthetics – healthcare research

Contact: Prof. Giuseppe Allocca, the University of Milan Faculty of Medicine Dentistry & Health Sciences, Via Festa del Perdono 7 – 20122 Milano – Dental School via della commenda 10-12 Milan, Email: alloccagiuseppe@unimi.it

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