

Case Report

Minimally Invasive Therapy for Treating White Spot Lesions on Anterior Teeth in Molar Incisor Hypo Mineralization

Zaghdoudi Hajer*; Douki Nabih; Ben Amor Faten

Oral Health and Oral Rehabilitation Research Laboratory (LR12ES11), Faculty of Dental Medicine, Monastir University, 5000 Monastir, Tunisia.

*Corresponding Author: **Zaghdoudi Hajer**

Oral Health and Oral Rehabilitation Research Laboratory (LR12ES11), Faculty of Dental Medicine, Monastir University, 5000 Monastir, Tunisia.
Email: hajer_za@yahoo.com

Article Info

Received: Jul 24, 2023

Accepted: Aug 16, 2023

Published: Aug 23, 2023

Archived: www.jclinmedsurgery.com

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Abstract

Molar Incisor Hypomineralization (MIH) is a systemic hypomineralization that can induce stained enamel opacities of anterior teeth. Due to high prevalence of these cases, it is important to propose an adequate therapeutic approach according to the shade, depth, and location of the lesions. Frequently these colorations are quite thick, deep which arise from the enamel-dentin junction and extend to the surface of the tooth and white, sometimes associated with yellowish colorations mainly in the areas of enamel breakdown. These opacities are considered the most difficult to treat among white spot lesions; dental bleaching alone, erosion/infiltration or composite resin restorations have long yielded unsatisfactory results. The idea of deep infiltration seems to solve this aesthetic concern and overcome these failures. According to the therapeutic gradient, it is an ultra-conservative technique that by conceding a slight mutilation of the enamel using a preparation by sandblasting or milling we manage to reach the ceiling of the lesion but always we still in the enamel layer. The respect of treatment steps, control by transillumination, alcohol testing and infiltration at the right time are the key to the success of the technique. However, more clinical perspective is needed to better understand the place of this therapy in daily practice.

Keywords: MIH; White spot lesions; ICON; Deep infiltration.

Introduction

Throughout its history, dentistry has experienced notable progress, transitioning from a concept based on functional and biological aspects to a modern evolution focused more on the patient, particularly their aesthetic concerns. Indeed, the smile constitutes the essence of social interactions, and depending on societies and cultures, it can be associated with intelligence, social status, confidence, and happiness [1,2].

Visible differences in dental appearance, such as enamel opacities, can have a considerable psychosocial impact on indi-

viduals, especially adolescents who are developing their sense of self, forming relationships, and striving to find their place in society [2,3].

These opacities represent a quality defect in the enamel, visually identified as a variable-sized whitish spot. From a histological perspective, it is characterized as enamel hypomineralization, where the organic phase outweighs the mineral phase, resulting in porous and permeable enamel [4,5]. Numerous factors can contribute to these lesions, such as prolonged plaque accumulation on the affected tooth surface, dental fluorosis, trauma, or molar incisor hypomineralization (MIH) [5,6]. How-

Citation: Hajer Z, Nabiha D, Amor Faten B. Minimally Invasive Therapy for Treating White Spot Lesions on anterior teeth in Molar Incisor Hypo mineralization. J Clin Med Surgery. 2023; 3(2): 1118.

ever, these discolorations may appear similar since they result from the same mechanism of action. Yet, in each case, hypomineralization takes on distinct topographic forms, which affect treatment decision and prognosis. Hence, the importance of meticulous clinical observation of the lesions and the use of specific tools like transillumination [6-9] to implement targeted therapeutic approach.

In this context, a range of options is available to treat these white lesions, the choice relies on the precise diagnosis of lesion location, depth, histopathological characteristics, and patient's age [3,4,7].

The aim of our article is to describe the aesthetic management of white spots on anterior teeth affected by MIH using the technique of deep infiltration. Emphasis will be placed on the essential characteristics of enamel lesions that guide diagnosis and treatment, as well as the key points for the success of this therapeutic approach.

Clinical case

A 14-year-old patient, in good general health, presents with an aesthetic discomfort related to white spots on his upper and lower anterior teeth.

Upon clinical examination, whitish spots are observed at the incisal third of the maxillary central incisors and the four mandibular incisors, along with dental plaque and tartar around the mandibular anterior teeth (Figure 1).

When examining the posterior teeth, carious substance loss is noted on tooth 26, a large amalgam restoration on tooth 46, and a fractured occluso-distal composite resin restoration on tooth 36 (Figures 2,3). Based on this clinical examination, we can deduce that the patient presents "Molar Incisor Hypomineralization (MIH)".



Figure 1: Clinical examination

- Diagnosis of enamel opacities :

Upper incisors:

- **Visual examination** reveals five essential characteristics of these lesions (Figure 4):

1. **Location:** The opacities are in the incisal third of the teeth, occupying almost half of the coronal height.



Figure 2: Superior arch occlusal view.



Figure 3: Inferior arch occlusal view.

2. **Color:** In tooth 11 the opacities appear white, with a yellowish zone at the incisal edge (area of substance loss). In tooth 21, the opacity is white with a yellowish zone in the center.

3. **Surface condition:** The surface of tooth 21 is smooth, while tooth 11 has mostly a smooth surface, except at the incisal edge where the surface is rough due to enamel breakdown.

4. **Opacity:** The opacities are opaque, indicating a loss of translucency in the affected enamel.

5. **Contour:** The contour of the opacities is irregular, suggesting an uneven and non-uniform appearance.

▪ **Transillumination**

Tooth 11: The lesion appears very dense with a mostly well-defined contour, blurred in its mesial part with substance loss.

Tooth 21: The lesion is dense in the distal part, and the rest appears blurry with poorly defined contour (Figure 5).

▪ **Topographic mapping of the lesion**

Creating a schematic representation of the shape, color, and contour of the lesions, which guide the diagnosis and treatment approach (Figure 6).

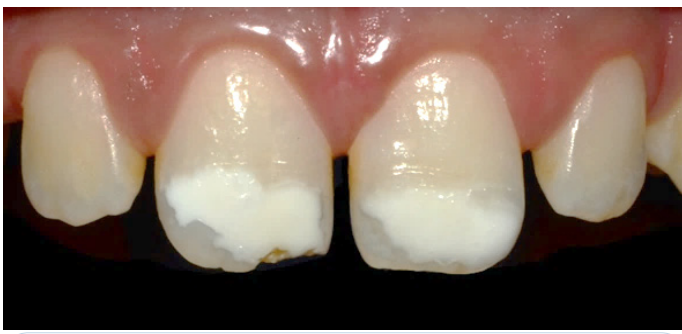


Figure 4: Visual examination.

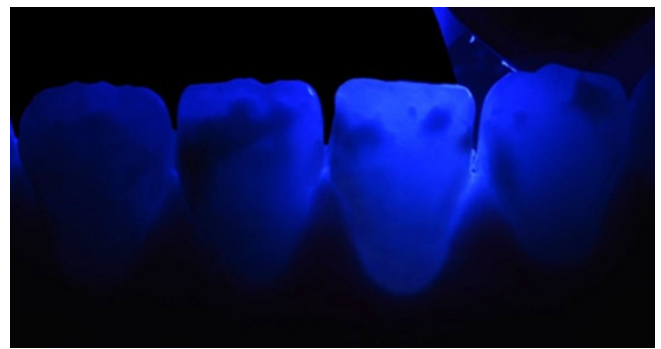


Figure 8: Transillumination.

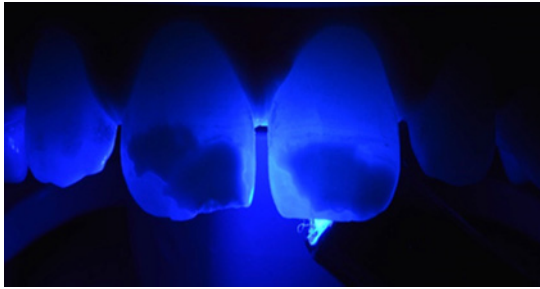


Figure 5: Transillumination.

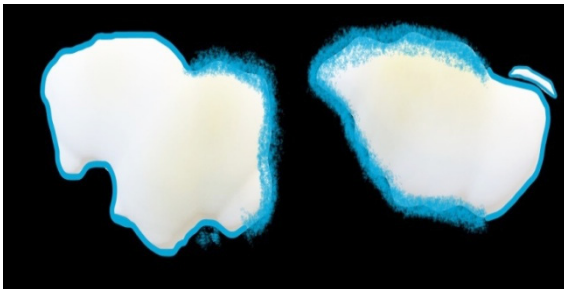


Figure 6: Topographic mapping of lesions on tooth 11 and 21.

Lower incisors:

The spots are in the incisal third, appearing white with a smooth surface, opaque, and an irregular contour (Figure 7).

Transillumination reveals a blurry appearance of the lesions (Figure 8).



Figure 7: Clinical examination.

- Treatment: Deep Infiltration

Upper incisors

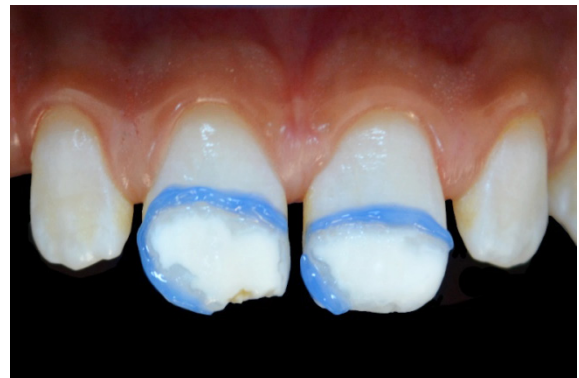


Figure 9: Lesion isolation using a light-cured resin protective barrier (Opal Dam® Ultradent) beyond 2 mm from the lesion boundaries.



Figure 10: Microabrasion (Opalustre® by Ultradent). 10 cycles of 10 seconds each for each tooth activated with a microbrush.

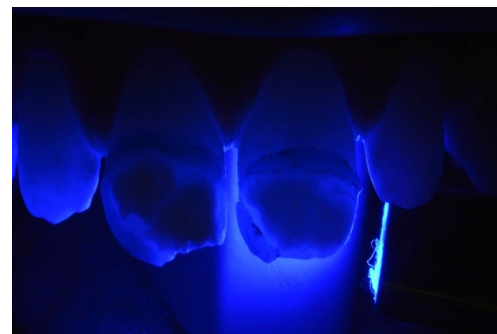


Figure 11: Transillumination test: the opacities have become slightly more homogeneous, but the boundaries remain blurry and poorly defined on tooth 21 and partially on tooth 11 near the incisal edge → The bottom of the lesion is not reached.

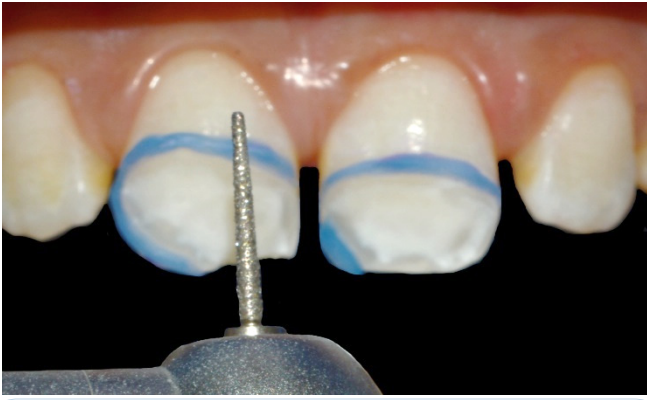


Figure 12: Removal of the enamel layer covering the lesions by gently abrading with a diamond burr.

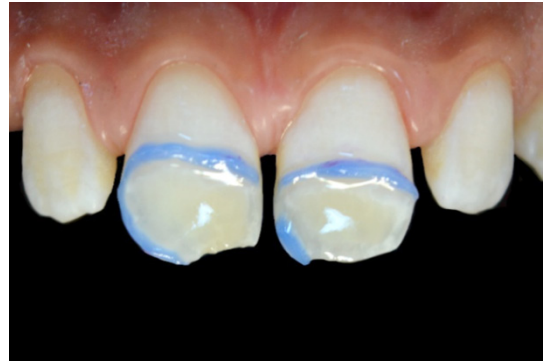


Figure 16: Dehydration of the lesion body using ethanol (Icon Dry, DMG) for 30 seconds. Predicts the result after infiltration.



Figure 13: Exposure of the lesions after milling: They show well-demarcated margins with a clear interface.



Figure 17: Result after resin infiltration (Icon Infiltrant, DMG) and photopolymerization for 40 seconds.

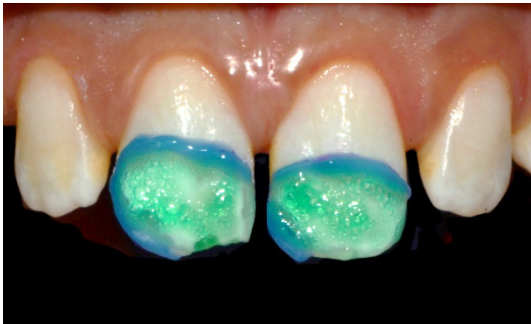


Figure 14: Erosion: Etching with 15% hydrochloric acid (Icon Etch) for 120 seconds.



Figure 18: Control of substance loss.



Figure 15: Deproteinization using a sodium hypochlorite gel (ClONa gel), activated with a microbrush for 60 seconds.



Figure 19: Final result after placement of a thin layer of composite resin (Enamel) to compensate the loss of substance caused by milling and restore the fractured portion of the mesial angle of the incisal edge of tooth 11.

lower incisors



Figure 20: Examination of the lesions by transillumination: Heterogeneous appearance, blurry with poorly defined contour → Deep lesions.

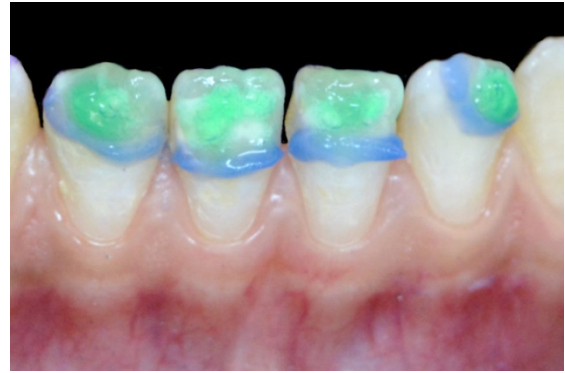


Figure 24: Erosion: Etching with 15% hydrochloric acid (Icon Etch) for 120 seconds.



Figure 21: Lesion isolation using a light-cured resin protective barrier (Opal Dam® Ultradent) followed by microabrasion, 10 cycles for each opacity.

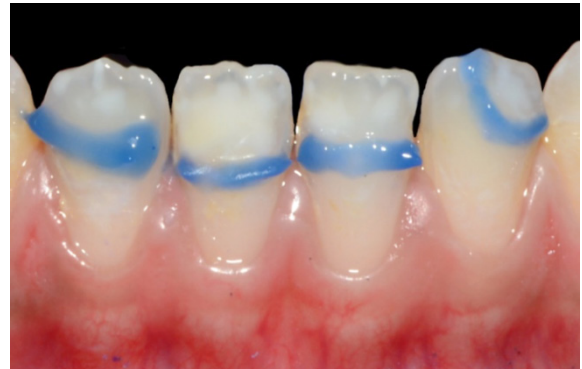


Figure 25: Deproteinization using a sodium hypochlorite gel (ClONa gel), activated with a mini-brush for 60 seconds, followed by the alcohol test: the opacities are still slightly visible → reapplication of acid erosion.



Figure 22: Clinical appearance of the lesions after a slight enamel mutilation using a fine-grit diamond burr.



Figure 26: Result after resin infiltration (Icon Infiltrant, DMG) and photopolymerization for 40 seconds.



Figure 23: Transillumination test: The opacities have become more homogeneous with well-defined boundaries → Exposure of the “ceiling of the lesion”



Figure 27: Final appearance after the application of a thin layer of composite resin (Enamel) to compensate for the loss of substance caused by the milling process.



Figure 28: One-week follow-up: The rehydration of the teeth has led to an improvement in the aesthetic appearance.

Discussion

Definition

The term Molar-Incisor Hypomineralization (MIH) was first introduced in 2001 by "Weerheijm and al" to describe a systemic origin hypomineralization with qualitative defects of enamel that occur asymmetrically on one or more of the permanent first molars, with or without involvement of the incisors [6,10,11,12].

Prevalence

A recent systematic review and meta-analysis conducted by "Schwendicke and al. 2018" estimated a global average prevalence of MIH at 12.9% (11.7-14.3%), with significant variations between countries. Another meta-analysis by "Zhao and al. 2018" estimated the prevalence of MIH to be around 14%, with no statistically significant difference between sexes, and it was found to be more frequent in patients under 10 years of age (15%) [13,14].

Etiology

Regarding the etiology of MIH, researchers have not yet reached a clear consensus. Most of the factors that have been implicated so far include childhood illnesses, medications taken during amelogenesis (such as antibiotics), environmental toxins, fever, asthma, and pneumonia [13,15,16].

4 The Pathogenesis and Aetiology of MIH: More Questions Than Answers 35

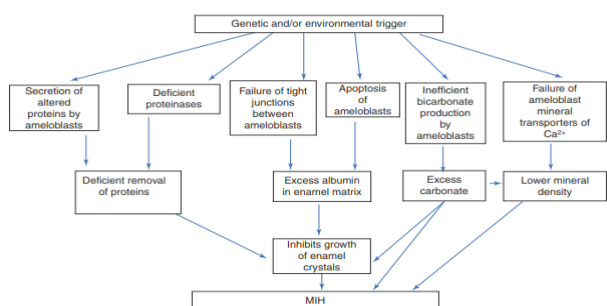


Figure 29: Potential biological processes leading to demarcated opacities [15].

Diagnosis of MIH

Historically, a variety of terms and definitions have been used to describe different enamel developmental defects. Regarding MIH, a set of diagnostic criteria has been established by Weerheijm and al. [11], three of which were diagnosed in our clinical case:

Table 1: Diagnostic criteria of MIH.

Demarcated opacities	– Clearly demarcated opacities – Variability in color and size
Posteruptive enamel breakdown	Surface defect or enamel loss on a surface that was initially formed after tooth eruption: on tooth 26 and on the incisal edge of the 11 (mesial angle).
Atypical restorations	Large amalgam restoration on tooth 46 and a fractured occluso-distal resin composite restoration on tooth 36.
Extraction of molars due to MIH	Not diagnosed in our case.
Failure of eruption of a molar or an incisor	

Differential diagnosis

Clinically, MIH can be confused with other structural anomalies. It is essential to understand the specific characteristics of each lesion to differentiate them and guide the treatment plan.

Table 2: MIH Differential Diagnosis

Amelogenesis Imperfecta (AI)	Due to the diverse clinical presentations of AI, some cases may be challenging to distinguish from MIH. However, the widespread involvement of primary and permanent teeth and a common family history can help guide the diagnosis toward a genetically based disorder.
Fluorosis	The teeth are symmetrically affected and show linear white, yellow, or brown opacities without clear boundaries in the enamel. In contrast, MIH does not exhibit diffuse opacities but rather well-defined opacities. Anamnesis focused on fluoride history can also help distinguish fluorotic lesions from opaque MIH lesions.
Enamel Hypoplasia	Clinically, hypoplasia can show a wide variation in the number of affected teeth and is rarely of regular shape. History of trauma or periapical inflammation of the primary tooth is most involved. The borders of hypoplastic lesions are generally regular and smooth, indicating a lack of enamel matrix formation during amelogenesis. In contrast, the margins of lesions related to MIH are irregular.
White Spot Lesions	They represent early sign of dental caries. They can be seen because of prolonged plaque accumulation on the affected tooth surfaces. These stains are distinguished from MIH by their cervical or gingival location, which are areas of plaque stagnation.

Characteristics of dental enamel in the case of MIH

Unlike other white enamel lesions, MIH-related lesions extend throughout the entire thickness of the enamel, starting at the enamel-dentine junction and ending at the surface [6,18,19].

Various methods such as optical microscopy, polarized light microscopy, scanning electron microscopy, and transmission electron microscopy have been used to study the structural properties of enamel affected by MIH [18,20]. These tools have shown:

- Significantly lower hardness and modulus of elasticity compared to sound enamel.
- Significant decrease in mineral density (approximately -20%).
- Significantly higher protein content.
- Increased porosity.

- Higher concentrations of carbon and carbonate.
- Thicker prism sheaths and higher inter- and intra-prismatic concentrations of organic particles [18,20].

Optically, the heterogeneity of the crystalline organization contributes to the disruption of the trajectory of light rays, causing all incident light to be reflected from these lesions, resulting in their whitish appearance [4].

As a result:

☞ Enamel in teeth affected by MIH poorly support underlying restorations due to its low hardness and low elasticity [18,20].

☞ The bond between enamel and adhesive restorations is often compromised due to an increased proportion of organic matrix [18].

☞ Acid etching prior to adhesive restorations, such as composite, induces more pores and cracks compared to sound enamel [18,21].

☞ This histological structure implies weak mechanical properties and explains the occurrence of cracks or fractures in teeth affected by MIH, hypersensitivity in some cases, difficulties in anesthetizing affected teeth, and increased susceptibility to carious lesions [12,10,22,10].

Diagnosis of white spots related to MIH

Visual examination

A thorough visual examination can allow us to read a "topographic mapping" of the lesion [7]. The teeth should be examined while wet; however, if necessary, cotton rolls can be used to clean the surface for better visualization of the lesions [11,13]. Some white lesions are only slightly whiter than sound enamel, and air drying may be necessary to detect them, while others are intensely white and easily visible even on a wet tooth surface [7].

Transillumination

Sound enamel is translucent. It not only allows the passage of light but also its dispersion. During transillumination, the teeth are illuminated from their lingual surfaces, and the light passes through the dental structure until it reaches the outer tissue. Thus, opacity is decomposed based on the amount of light that reaches the surface.

This simple, non-invasive, and painless method is useful for mapping white enamel lesions in the anterior teeth. It increases the contrast between sound enamel and hypomineralized enamel, allowing a better evaluation of the number of lesions, their boundaries, and their depths [7,9,20].

Based on visual examination and transillumination, a new topographic classification of white spots has been established (WSTC) [4,7]:

Table 3: White spot topographic classification (WSTC).

Superficial lesions		Deep lesions	Mixed lesions
Depending on the thickness of the lesion, the appearance may be:		<ul style="list-style-type: none"> The lesion is covered by translucent sound enamel that disperses light away from the spot, which appears blurred with poorly defined boundaries. Creamy and yellowish appearance. 	A portion of the lesion is deep, while the other part is superficial.
Thin superficial lesions	Thick superficial lesions		
<ul style="list-style-type: none"> Slightly whiter than sound enamel. Difficult to distinguish from underlying enamel. Can only be detected after prolonged air drying. 	<ul style="list-style-type: none"> Much whiter compared to sound enamel. Easy to distinguish from underlying enamel. Visible even on a wet surface. 		

This classification has a purely therapeutic purpose as it clinically guides us towards the appropriate treatment option for each lesion based solely on its topography [7]. For our clinical case, based on this classification, we can conclude that the white lesions associated with the upper incisors are mixed, while those on the lower teeth are deep.

Treatment

In every aesthetic demand biological, biomechanical, functional, and aesthetic imperatives are inseparable, and the practitioner must choose a solution adapted to the clinical situation from a range of treatments, from the most conservative to the least conservative [23].

In the case of MIH, the enamel lesions have the particularity of starting not in the subsurface, but at the amelodentinal junction. They have an internal location that is not easily reached by the standard erosion protocol. Therefore, the principle of treatment by deep erosion/infiltration of MIH is to remove the ceiling of the lesion through sandblasting or milling before infiltration, followed by restoration with composite resin to ensure satisfactory aesthetic results [8,24,25]. Indeed, this area cannot be reached during the successive stages of erosion (multiple applications of HCl), and infiltration may occur at the level

of sound enamel, producing no favorable optical effect. That is why treatments by erosion/infiltration of MIH lesions were rarely successful [6,24]. However, the option of deep infiltration can only be successful through the respect and understanding of each step of the treatment and the knowledge of the mechanism of different products used.

- **Lesion isolation:** Creates a barrier between sound enamel and hypomineralized enamel and minimizes the waste of various products required for the abrasion-infiltration protocol. After photopolymerization, this barrier should remain in place throughout all treatment phases [26].

- **Microabrasion:** For an ultra-conservative approach, the removal of superficial enamel layers was attempted to expose the lesions. A total of 10 cycles of microabrasion were performed, reducing the enamel thickness by 25 to 200 µm, which proved to be insufficient to reach the ceiling of the lesions [27].

- **Macroabrasion:** Through milling, this approach is slightly more invasive, but still limited to the enamel. The concept behind this technique is based on the removal of the superficial layer of tissue recovering the white spot and transforming a non-superficial enamel lesion into a superficial one which is exposed before its infiltration [3,13,24].

- **Deproteinization:** The purpose of deproteinization with sodium hypochlorite is to remove organic barriers that hinder infiltration. Hypomineralized enamel contains a significant protein component that limits resin infiltration. Sodium hypochlorite (NaOCl) eliminates this protein component and increases the porosity of hypomineralized enamel. This enhances the capillary effect underlying infiltration. Some authors recommend rinsing the lesions with 5% sodium hypochlorite for 5 minutes. In our clinical case, we opted for the use of sodium hypochlorite gel (NaOCl gel), which provides better stability and maximum contact with the tooth surface. Mechanical activation using a microbrush for 60 seconds optimizes its effectiveness, allowing targeted action limited to the affected enamel with less risk of splashing [28,26].

- **Substance loss control:** Substance loss is ideally measured using a thickness caliper. It indicates that the technique is minimally invasive and suggests the need for an additional restorative technique.

- **Transillumination test:** The removal of the enamel layer covering the lesion is an essential prerequisite before any infiltration procedure. Transillumination, in addition to its diagnostic value, confirms the exposure of the bottom of the lesion [26].

- **Alcohol test:** The main challenge of this therapeutic approach is knowing when to infiltrate the enamel opacity. Alcohol (ethanol) serves as an indicator of the position of the lesion's ceiling. With its relatively high refractive index, it shows the result that will be obtained after resin infiltration. As soon as the application of alcohol slightly masks the spot, it indicates that we have reached the ceiling of the lesion and the infiltration will be sufficient to conceal it. If alcohol does not provide this effect and the lesion remains white-opaque, it becomes necessary to repeat one or two steps of chemical erosion (HCl) because it has been reported that 29% of these opacities have a thicker superficial enamel layer exceeding 50 µm, making it difficult to create enough porosity with a single application of 15% HCl or, as in our case, further milling the enamel covering the spots to reach the lesion's ceiling. In any case, infiltration should never be performed if alcohol does not mask the lesion [24,28,29].

- **Infiltration step:** The main component of the infiltrating resin is triethylene glycol dimethacrylate (TEGDMA), a low viscosity and highly fluid resin monomer with a refractive index (1.52) close to that of sound enamel (1.62). It improves the transmission of light photons through the hypomineralized enamel and restores its translucent appearance [8,24]. In addition to its aesthetic properties, this resin increases the mechanical strength of demineralized enamel and makes it more resistant to acid attack compared to sound enamel. This is due to the ability of the resin infiltrant to impregnate the interprismatic enamel and form a reinforced resin-enamel tissue called the hybrid layer, which is distinguished from dentin hybrid layers by the absence of collagen fibers [29,31]. However, the sealing properties of this product may be insufficient. It has been reported that it can only seal about 60% of the enamel pore volume, leaving a significant amount of untreated demineralized enamel. As a result, incomplete infiltration will result in the persistence of an unaesthetic edge effect that can be easily detected by transillumination. In this context, rehydration is of crucial importance. Over time, the infiltrated lesion undergoes water absorption, improving the translucency of the enamel (72 hours to one week) [4]. Recently, a new nano-structured resin

infiltrant containing amorphous calcium phosphate nanoparticles (NACP) has been incorporated into ICON for the treatment of white enamel lesions. The addition of 30% NACP to the ICON resin has allowed for long-term release of Ca and P ions, acceptable biocompatibility, and the promotion of hardness and mineral component deposition after a 14-day period [30].

- **Composite resin restoration:** MIH stains are not always completely masked by resin infiltration alone. In certain situations, such as in our case, the use of composite resin above the infiltrated areas is necessary to achieve an optimal result. Placing composite resin without deep infiltration will result in the inability to mask the lesion, a highly unsatisfactory aesthetic outcome, and insufficient application of the composite resin due to the limited space unless the lesion is removed down to the dentin, which goes against the principle of tissue preservation [3,13,27].

The choice of adding enamel or dentin composite depends on the extent of substance loss: minimal loss, as in our clinical case, requires the addition of enamel composite only, while in the opposite case, both enamel and dentin composites are necessary to fill the area. Additionally, the composition of the resin material is an important criterion, especially for anterior restorations. In our clinical case, a nanohybrid resin (Opallis) was used, which has an average particle size of 0.5 µm. Compared to microhybrid composite resins, "nanotechnology" has allowed the incorporation of new compounds with particle sizes smaller than visible light wavelengths, thereby improving aesthetics, surface quality, and better light transmission through the restoration. Moreover, these composites have shown good resistance to wear, compression, and fractures, low polymerization shrinkage, ease of shaping, and quick polishing. Such differences should be taken into consideration to achieve aesthetic restorations that closely resemble natural teeth [32,33].

Prognosis

The treatment of enamel opacities using the deep infiltration technique with ICON remains a highly conservative approach, ensuring a good long-term prognosis. However, many authors have questioned the aging of the infiltrated resin, and recent *in vitro* studies seem contradictory on this subject. Some find that the infiltrated enamel shows stability for at least 6 months, while others believe that the demineralized infiltrated tooth structure is more susceptible to external discoloration. Indeed, through experimental studies, researchers have shown that over time, black tea, black coffee, and red wine can alter the hue of the infiltrated enamel [24,34,35]. Based on these observations, some authors recommend ambulatory bleaching for patients with discolored enamel lesions, even after resin infiltration treatment [34,35]. In this context, Rocha and al. (2020) studied the limited effectiveness of bleaching on these lesions and showed that the resin infiltrant acts as a semi-permeable physical barrier to the bleaching agent, reducing the permeability of the enamel surface and decreasing the number of free radicals, which hinders the degradation of pigment molecules. However, further studies are needed to detect such an influence and supplement the results of current research [36].

It is essential to note that the problem of discoloration of the infiltrating resin primarily occurs in cases of superficial infiltration because, in deep infiltration, such as in our clinical situation, the infiltrating resin is not in contact with the external environment, except through its adhesive seal, and is covered by composite resin, which, in turn, may require maintenance and

replacement over time. Indeed, composite restorations have a limited lifespan, and marginal stains, wear, and fractures may occur. Long-term maintenance is therefore essential for the success of the treatment [24,13,27].

Role of external bleaching in the management of MIH-related enamel lesions

The color of hypomineralized enamel in cases of MIH can range from white to yellow or brown. In the case of colored stains, whether they are superficial or deep, resin infiltration may prove ineffective. Indeed, during the infiltration of the lesion, a distinct color resurgence appears, and the treated areas may appear more yellowish. In the case of superficial infiltration, the failure is immediate, and even in cases of deep infiltration, it will be challenging to hide this discoloration with composite. Ideally, the colored stain should be transformed into a whitish stain through prior tooth whitening, followed by infiltration. It may happen that the whitening alone is sufficient by reducing the contrast between the tooth color and the lesion and the patient is satisfied with the result.

After tooth whitening, a period of at least 15 days before infiltration is essential. Indeed, the physical and chemical alterations that may occur in the enamel immediately after the whitening procedure can lead to a loss of resin adhesion to the enamel. Additionally, the presence of residual oxygen in the whitened enamel hinders the resin polymerization process. Color stability and normal bond strength are achieved within three weeks following the whitening procedure [24,37,38].

Conclusion

So far, there is no minimally invasive aesthetic solution available to effectively treat enamel opacities related to MIH. In some cases, a combination of multiple therapeutic protocols may be necessary to meet the aesthetic needs of patients.

The concept of deep infiltration involves a slight removal of sound enamel to reach the ceiling of the lesion, but it remains within the thickness of the enamel. This approach aims to preserve maximum tooth structure and avoid more invasive treatments.

However, it is important to note that further clinical experience and long-term studies are needed to fully understand the effectiveness and role of this therapy in daily practice.

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