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Clinical Features of Anterior Teeth Affected by Molar Incisor Hypomineralization and Treatment Experiences Using Transilluminated Light: A Cross-Sectional Study

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ORIGINAL ARTICLE

Clinical Features of Anterior Teeth Affected by Molar Incisor Hypomineralization and Treatment Experiences Using Transilluminated Light: A Cross-Sectional Study

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ABSTRACT

Classification and resin infiltration treatment of MIH-related permanent anterior teeth are increasingly receiving attention nowadays. **Objective**: The study aims to evaluate the characteristics of these teeth; and to assess factors regarding treatment. **Methods**: A cross-sectional study was conducted using transilluminated and reflected light photographs, and the lesion was classified according to its color, size, type, heterogeneity and surface integrity. The data were analyzed using a chi-square test and multivariate logistic regression analysis to evaluate enamel craze lines (ECL), post-eruptive breakdown (PEB), and treatment procedures. **Results**: 73 teeth from 46 patients were included, in which 53 teeth had been treated. Size I showed the highest rate of PEB (66.67%). Females (OR = 20.39 (95%CI: 1.62 – 256.18)) and colored lesions (OR = 13.01 (95%CI: 1.82 – 93.13)) were associated with ECL/PEB. Microabrasion and etching cycles were inversely proportional and PEB required 4.33 etching cycles on average. A significant relationship was observed between surface integrity and composite fillings, between yellow/brown spot transformation and lesion color, sex and homogeneity. **Conclusion**: Lesion color, size, and sex are significant factors influencing ECL and PEB, while sex, surface integrity, lesion color, and homogeneity affect the treatment. Dental practitioners should consider these factors to provide appropriate treatment planning and consultation.

Key words: classification, enamel opacity, image processing, molar incisor hypomineralization, transillumination

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INTRODUCTION

Molar incisor hypomineralization (MIH) is a qualitative developmental defect of the enamel of one or more first permanent molars with or without the involvement of incisors with a demarcated boundary with multifactorial causes.[1] MIH was present before the 21st century.[2] Despite being detected among ancient populations,[3,4] the condition was first identified in 1987 by Koch and first defined in 2001.[5,6] Several recent studies claim that MIH has been a frequently encountered dental condition worldwide. The study by Vo Truong Nhu Ngoc about the relationship between MIH and primary teeth trauma in 12- to 15-year-old pupils in Hai Phong, Binh Dinh, and Thanh Hoa in Vietnam showed that the total prevalence of MIH among participants was 20.1%. In contrast, its prevalence in the molars and incisors was 10.6% and 11.4%, respectively.[7] The condition could be linked with several complications such as hypersensitive teeth, dental caries, mastication impairment due to rapid attrition, and esthetic consequences (including demarcated opacities or even post-eruptive enamel breakdown). These might have a negative effect on the patient's quality of life as well as creating significant treatment challenges to dentists.[1,6,8] As a result, MIH deserves increased attention as a global concern for dental public health.[1,2,6,8]

The causative factors for MIH remain ambiguous. Despite numerous studies aiming to decide the etiological factors of MIH, the exact etiology of MIH still needs to be determined. However, it is considered to be multifactorial with genetic and/or epigenetic components. Most putative factors identified to date involve childhood illness, medication taken during amelogenesis process and environmental toxins.[1,8-10]

Despite a number of categorization systems of MIH lesions,[8,11-14] there seems to remain a lack of specific criteria with the aim of prognosing them for assisting the treatment planning process. Among these systems, the European Academy of Paediatric Dentistry (EAPD) criteria is used the most extensively, but it still pays considerable attention to the lesion color and size.[11] Many studies only consider defects larger than 1 mm and classify only the most critical lesion when multiple lesions exist on a surface. This is because the indices used in these studies focus on molar teeth rather than anterior teeth.[13] A new classification has been proposed based on lesion color, size, heterogeneity, and enamel surface integrity, focusing on anterior teeth instead of molars.[15] Appropriate treatment decisions for anterior teeth must consider several factors at multiple levels including the patient, oral, and teeth level. Several treatment options exist, such as the etch-bleach-seal technique, external bleaching, composite restorations, microabrasion, resin infiltration, or a combination of these procedures.[1,8,16,17] Notably, the resin infiltration treatment option, deemed a minimally invasive treatment using the ICON system, is improving and receiving significant attention in dentistry.[18-20] The infiltrated resin can fill the spaces between the crystallites, creating an enamel hybrid layer.[16,17] Despite several treatment options, there still needs treatment prognosis for dental consultation.[7,8,16,17]

Therefore, our study aims to (1) evaluate the clinical characteristics of MIH-related lesions on permanent anterior teeth; and (2) to assess factors related to treatment procedures for feasible dental consultation.

METHODS

This cross-sectional study was performed at Nhu Ngoc Dental Clinic, Phuong Thanh Dental Center, and some private dental clinics in Vietnam from October 2022 to June 2023.

Clinical examination of teeth dried with gauze was performed under standardized lighting, and individuals with permanent incisors and canines with defects greater than 1 mm located on the incisal and middle thirds of the buccal surface were invited to participate in the study after a diagnosis of MIH according to the definition of Weerheijm.[5,8]

Exclusion criteria were as follows: No first permanent molar diagnosed of MIH, teeth with resin composite restorations, or previously treated with micro-abrasion, remineralization (fluoride varnish or calcium-based products such as CPP-ACP), endodontic therapies or external bleaching.

Data collection

Included teeth were thoroughly cleaned and dried with gauze. Clinical images were taken using a digital single-lens reflex camera (D810; Nikon Corp.) and 105-mm macro lens (SP AF105 mm F⁄2.8G; Nikon Corp.) 1:1 magnification, using incident light reflected from the buccal surface. Standardized reflected light (RL) and transilluminated light (TL) photographic images were taken for each tooth.

For RL images, settings were set at F/40 aperture with 1/125-s shutter speed and ISO 125, using flash illumination (YN-24X TTL Macro Flash; Yongnou Corp.) with 5000K white balance. For TL images, we use the EP light as well as O-Star curing light with the same parameters except for the fact that ISO was 800.

Classification of MIH-affected lesions

Our study has applied the recent classification of Omar Marouane and David J. Manton.[15]

Lesion color, size, and heterogeneity

For a comprehensive assessment, our study evaluated crucial clinical parameters of the lesion including the color, size and level of heterogeneity (Figure 1). In more detail, the lesion color was evaluated based on the RL images, whereas the size and opacity of the lesion body were both primarily estimated according to the TL images. The criteria for each classification were as follows:

- Lesion color consists of two classifications, which shows white/creamy opacity (non-colored, NC) in Figure 1-A, and yellow/brown opacity (colored, C) in Figure 1-B.
- For heterogeneity, the lesion is deemed heterogenous (He) in Figure 1-C or homogenous (Ho) in Figure 1-D. In the presence of PEB, the heterogeneity is determined according to the remaining intact tissue.
- There are three classifications for the lesion size, including size I (smaller than 1/3 of the tooth surface was detected as the lesion) for Figure 1-E, size II (at least 1/3 but smaller than 2/3 of the tooth surface was involved) for Figure 1-F, and size III (at least 2/3 of the tooth surface was affected) for Figure 1-G.

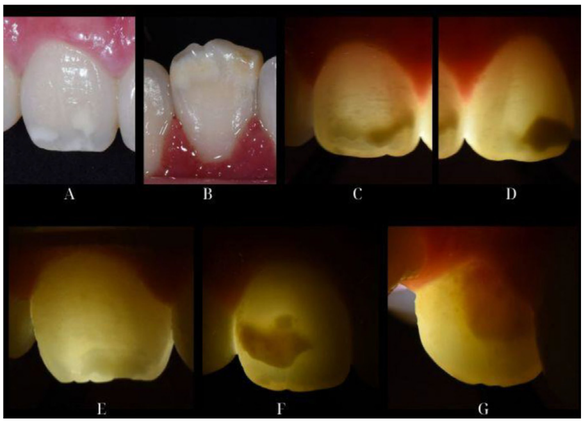

Figure 1. Lesion color, heterogeneity and lesion size. Lesion color was shown as white/creamy (A) or yellow/brown (B). The lesion was deemed heterogenous (C) or homogeneous (D); while the size was classified into size I - smaller than 1/3 of the tooth surface was detected as the lesion (E), size II - at least 1/3 but smaller than 2/3 of the tooth surface was involved (F) or size III - at least 2/3 of the tooth surface was affected (G).

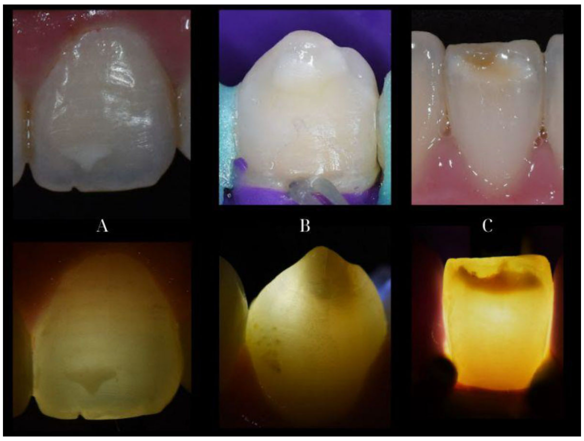

Figure 2. Evaluation of surface integrity. Transilluminated and reflected images representing (A) sound surface - SS, (B) enamel craze lines - ECL, and (C) post-eruptive breakdown – PEB.

Surface integrity
The clinical surface integrity was demonstrated as sound surface (SS), enamel craze lines (ECL), and post-eruptive breakdown (PEB) via both the TL and RL images for an improved evaluation (Figure 2).

Lesion type
According to the appearance of the opacity of the lesion body as well as the quantity of involved areas found in the affected tooth via the TL and RL images, the study included three lesions types (Figure 3), which were classified as type I (Figure 3-A) if the affected area presented an isolated, demarcated with homogeneous opacity; as type II (Figure 3-B) if it demonstrated an isolated, demarcated but non-homogeneous opacity with extension(s), which was (were) less opaque than the primary defect; as type III (Figure 3-C) lesion if

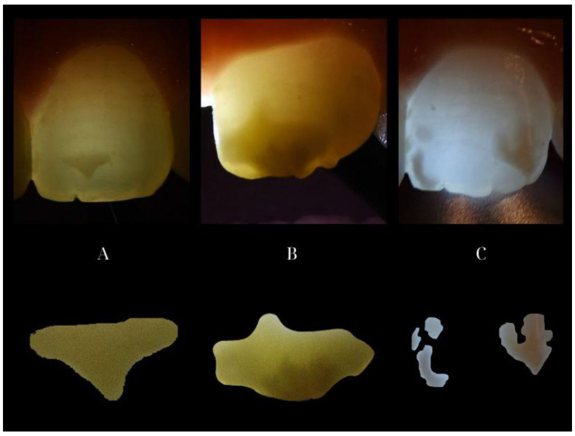

Figure 3. Lesion types. Lesion types were categorized into (A) type I if the affected area presented an isolated, demarcated with homogeneous opacity; (B) type II if it demonstrated an isolated, demarcated but non-homogeneous opacity with extension(s), which was (were) less opaque than the primary defect or (C) type III if it illustrated multiple isolated demarcated opacities separated by a sound enamel portion, appearing as secondary defects revolving around a type I or II defect.

it illustrated multiple isolated demarcated opacities separated by a sound enamel portion, appearing as secondary defects revolving around a type I or II defect. Notably, that secondary lesion involved decreased size and opacity compared to the principal defect (type II).

Treatment procedure
Based the treatment procedure on the ICON Decision Tree and the new treatment guideline of EAPD,[8] we have established the treatment protocol for MIH-affected lesions using resin infiltration by ICON DMG (ICON system, DMG, Hamburg, Germany) (Figure 4). For some specific cases, we also perform Yellow/Brown spot transformation (5% Sodium Hypochlorite). Our treatment procedure could be demonstrated via five main stages as follows:

- Stage 1: Isolation and cleaning
  - Clean the affected teeth and then isolate them with the rubber dam.
- Stage 2: Microabrasion with Opalustre (Ultradent, UT, USA)
  - Add a sufficient amount of Opalustre (Ultradent, UT, USA) to the affected lesion. Then, use a low-speed handpiece with OpalCups (Ultradent, UT, USA) to micro-abrade the surface of the affected lesion for 60 seconds, with two 30-second turns.
  - If necessary, perform additional cycles after applying Icon Etch and Icon Dry.
- Stage 3: Icon Etch and Icon Dry (ICON System, DMG, Hamburg, Germany)
  - Apply a sufficient amount of Icon Etch (ICON System, DMG, Hamburg, Germany) to the af-

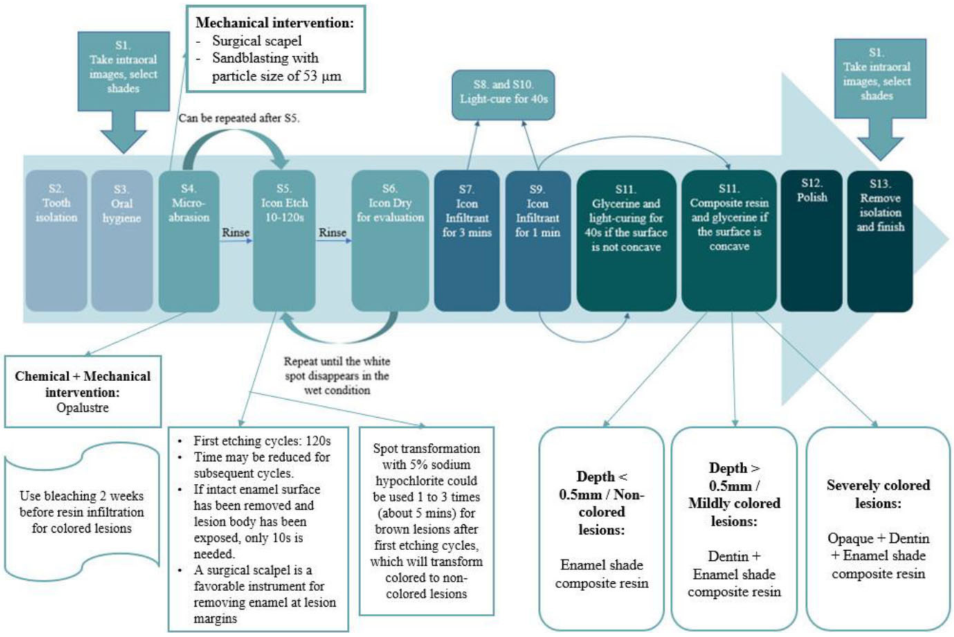

Figure 4. Our treatment stages for MIH-related lesions using resin infiltration with ICON DMG (ICON system, DMG, Hamburg, Germany).

fected lesion for 120 seconds per cycle, then rinse for 40 seconds.

- Dry the tooth surface with air and apply the Icon Dry (ICON System, DMG, Hamburg, Germany) for evaluation. If there is an optical change (i.e. the opacity disappears in the wet condition) in the affected surface, proceed to Stage 4. If there is no change, repeat Stage 3.

- Stage 4: Icon Infiltration (ICON System, DMG, Hamburg, Germany)
  - Apply an adequate amount of Icon Infiltration (ICON System, DMG, Hamburg, Germany) to the affected lesion for 180 seconds, then light-cure it for 40 seconds.
  - After that, apply a proper amount of Icon Infiltration (ICON System, DMG, Hamburg, Germany) to the affected lesion for 60 seconds, then light-cure it for 40 seconds.
- Stage 5: Possible composite fillings, glycerin, and polishing
  - A concavity may develop due to microabrasion and etching; therefore, composite restorations might be required for deep opacities.
  - After restoring the tooth with composite resin, apply a generous amount of glycerin to the composite restoration area and light-cure it for 40 seconds. Then, proceed with polishing to achieve the best aesthetic outcome.
- Possible stage: Yellow/Brown spot transformation with 5% Sodium Hypochlorite

For teeth with yellow/brown lesions, if the color remains unchanged after the first etching cycle, apply small cotton balls soaked in 5% sodium hypochlorite to the affected lesion for 5 minutes to whiten the colored lesion. This process can be repeated several times for better color transformation.

Data analysis

Statistical analysis was performed using STATA version 16.0. The data were analyzed using the chi-square and STATA version 16.0 tests with a level of statistical significance of $p \leq 0.05$. Cohen's Kappa for two raters with 95% Confidence Interval (95% CI) was utilized for all diagnostic variables (color, size, heterogeneity, surface integrity and lesion type), which ranged from 0.80 to 0.95 – Strong to Almost perfect ($p < 0.001$). A multivariate logistic regression analysis was also performed.

Ethical consideration

All patients and their parents/guardians were given informed consent before the beginning of the study. Clinical examination and treatment caused no adverse effects, and the data was used for research purposes only. The study has also been approved by the local ethics committees of Nhu Ngoc Dental Clinic (following the Ethical Research Approval number as 12/QĐ – NKNN) and Phuong Thanh Dental Center (following the Ethical Research Approval number as 11/QĐ - NKPT).

Table 1. Association of clinical parameters in relation to surface integrity and lesion color.

Variables	Surface integrity			Color	
	SS (%)	ECL (%)	PEB (%)	NC (%)	C (%)
Age range					
≤ 11 years old	33 (54.1)	1 (33.33)	6 (66.67)	25 (54.35)	15 (55.56)
> 11 years old	28 (45.9)	2 (66.67)	3 (33.33)	21 (45.65)	12 (44.44)
Sex					
Male	25 (40.98)	2 (66.67)	2 (22.22)	14 (30.43)*	15 (55.56)*
Female	36 (59.02)	1 (33.33)	7 (77.78)	32 (69.57)*	12 (44.44)*
Color					
NC	43 (70.49)*	1 (33.33)*	2 (22.22)*	Not applicable	
C	18 (29.51)*	2 (66.67)*	7 (77.78)*		
Size					
Size I	46 (75.41)	2 (66.67)	6 (66.67)	35 (76.09)	19 (70.37)
Size II	14 (22.95)	0 (0)	3 (33.33)	11 (23.91)	6 (22.22)
Size III	1 (1.64)	1 (33.33)	0 (0)	0 (0)	2 (7.41)
Heterogeneity					
Heterogeneous	33 (54.1)	0 (0)	3 (33.33)	26 (56.52)	10 (37.04)
Homogeneous	28 (45.9)	3 (100)	6 (66.67)	20 (43.48)	17 (62.96)
Type					
Type I	21 (34.43)	0 (0)	2 (22.22)	17 (36.96)	6 (22.22)
Type II	16 (26.23)	2 (66.67)	5 (55.56)	10 (21.74)	13 (48.15)
Type III	24 (39.34)	1 (33.33)	2 (22.22)	19 (41.30)	8 (29.63)

*$p < 0.05$. SS: Sound surface, ECL: enamel craze line, PEB: post-eruptive breakdown, NC: non-colored lesion, C: colored lesion.

RESULTS

General characteristics of study subjects

In terms of the inclusion criteria, 46 patients at the age of 6 to 30 years old with 1 to 5 teeth affected were selected for the study, while the proportion of females was roughly 1.5 times higher compared to their counterparts (58.70% versus 41.30%). Looking at the individual teeth, there were a total of 73 anterior permanent teeth diagnosed with MIH, in which 44 were female teeth and the majority of lesion distribution were observed for maxillary central incisors (60.27%).

Clinical features of MIH-related lesions

There is an obvious association between lesion colors and the surface integrity of the affected teeth (Table 1). More detail, a higher proportion of teeth with PEB was seen for those with a yellow or brown lesion (7 out of 9). Moreover, sex was also observed to have a statistically significant relationship with lesion color, in which males have a higher percentage of having a colored lesion (55.56%).

This was further reinforced when performing the multivariate logistic regression analysis regarding lesion colors as the dependent variable (Table 2), showing that females were 4 times less likely to develop a yellow/brown lesion (OR = 0.25 (95%CI: 0.08 – 0.75)). Notably, the PEB lesion were about 13 times more likely to be seen in a yellow/brown color compared to the sound surface, which bolstered the result from the analysis considering surface integrity as the dependent variable. In more detail, colored lesions had the higher risk of developing ECL or PEB (OR = 13.01 (95%CI: 1.82 – 93.13)). The larger likelihood of developing a damage to the surface integrity could also be observed for female patients (OR = 20.39 (95%CI: 1.62 – 256.18)).

Factors influencing treatment modality with resin infiltration

During the time of the study, 53 teeth had been successfully treated using the resin infiltration technique described above, which are currently on a positive follow-up; while the remaining were only at the diagnostic stage. Unfortunately, there was no size III lesion treatment at the time of conducting the research.

Among surface integrity classifications, treatment procedures for teeth with post-eruptive breakdown required the lowest number of etching cycles (at approximately 4 cycles), while regarding the number of Opalustre cycles, the largest quantity of etching

Table 2. Multivariate logistic regression analysis for different dependent variables including surface integrity, lesion color and the need for spot transformation.

Variables	aOR	95%CI
Dependent variable: Surface Integrity		
Color		
White/creamy (NC)	1 [Ref]	
Yellow/brown I	13.01	1.82 – 93.13
Sex		
Male	1 [Ref]	
Female	20.39	1.62 – 256.18
Size		
Size I	1 [Ref]	
Size II	2.26	0.38 – 13.43
Size III	41.36	0.83 – 2072.75
Age range		
≤ 11 years old	1 [Ref]	
> 11 years old	1.20	0.22 – 6.47
Heterogeneity		
Heterogeneous lesion	1 [Ref]	
Homogeneous lesion	0.09	0.005 – 1.581
Type		
Type I	1 [Ref]	
Type II	1.74	0.09 – 35.13
Type III	0.22	0.007 – 7.086
Dependent variable: Color		
Sex		
Male	1 [Ref]	
Female	0.25	0.08 – 0.75
Surface Integrity		
Sound surface (SS)	1 [Ref]	
Enamel craze line (ECL)	3.90	0.29 – 52.22
Post-eruptive breakdown (PEB)	13.04	2.22 – 76.48
Dependent variable: Spot transformation using 5% NaClO		
Color		
White/creamy (NC)	1 [Ref]	
Yellow/brown I	7.24	1.15 – 45.67
Sex		
Male	1 [Ref]	
Female	23.50	1.48 – 374.40
Size		
Size I	1 [Ref]	
Size II	0.60	0.07 – 6.23
Age range		
≤ 11 years old	1 [Ref]	
> 11 years old	2.51	0.39 – 16.02
Heterogeneity		
Heterogeneous lesion	1 [Ref]	
Homogeneous lesion	26.93	1.96 – 370.66
Type		
Type I	1 [Ref]	
Type II	6.76	0.45 – 101.0
Type III	11.66	0.97 – 140.26

aOR=adjusted odds ratio;95% CI=95% Confidence Interval;[Ref]=Reference point

Table 3. Distribution of clinical parameters in relation to the need for composite filling and spot transformation.

Variables	Composite filling		Spot transformation	
	Used (%)	Not used (%)	Used (%)	Not used (%)
Age range				
≤ 11 years old	12 (48)	12 (42.86)	4 (33.33)	20 (48.78)
> 11 years old	13 (52)	16 (57.14)	8 (66.67)	21 (51.22)
Sex				
Male	9 (36)	10 (35.70)	1 (8.33)*	18 (43.9)*
Female	16 (64)	18 (64.30)	11 (91.67)*	23 (56.1)*
Color				
White/creamy (NC)	13 (52)	18 (64.29)	5 (41.67)	26 (63.41)
Yellow/brown I	12 (48)	10 (35.71)	7 (58.33)	15 (36.59)
Size				
Size I	18 (72)	24 (85.71)	10 (83.33)	32 (78.05)
Size II	7 (28)	4 (14.29)	2 (16.67)	9 (21.95)
Heterogeneity				
Homogeneous	14 (56)	16 (57.14)	10 (83.33)*	20 (48.78)*
Heterogeneous	11 (44)	12 (42.86)	2 (16.67)*	21 (51.22)*
Type				
Type I	9 (36)	9 (32.15)	4 (33.33)	14 (34.15)
Type II	9 (36)	9 (32.15)	3 (25)	15 (36.59)
Type III	7 (28)	10 (35.70)	5 (41.67)	12 (29.26)
Surface Integrity				
Sound surface (SS)	16 (64)	26 (92.86)	8 (66.67)	34 (82.93)
Enamel craze line (ECL)	2 (8)	0 (0)	0 (0)	2 (4.88)
Post-eruptive breakdown (PEB)	7 (28)	2 (7.14)	4 (33.33)	5 (12.19)

*$p < 0.05$

cycles was observed for the use of 1 microabrasion cycle (requiring around 6 etching cycles). Apart from not using microabrasion and using 4 microabrasion cycles (with no standard errors), the figure for etching cycles seemed to decrease as the quantity of Opalustre cycles increased.

The choice of whether to use spot transformation with 5% sodium hypochlorite during the treatment or composite filling after the treatment could be analyzed in Table 3. For a total of 53 teeth that we treated with resin infiltration that required spot transformation, most of which are from female patients with 91.67% ($p < 0.05$). Moreover, the majority of teeth transformed with sodium hypochlorite was observed for the homogenous lesions (83.33%).

Most of these statistically significant associations were further evaluated with the multiple logistic regression analysis, with spot transformation as the dependent variable (Table 2). It was noticeable that the colored

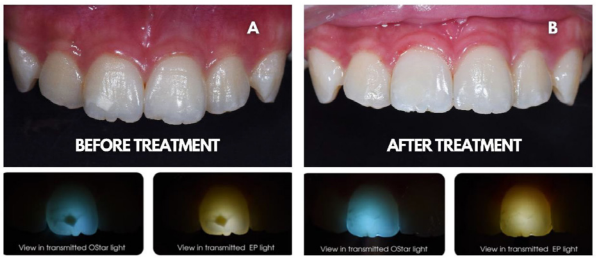

Figure 5. A clinical case report. This clinical case shows that the white defect on the labial surface of the upper right first incisor before treatment (A) has disappeared, which results in the positive aesthetic outcome after treatment (B) in both transilluminated and reflected images.

lesion (OR = 7.24 (95%CI: 1.15 – 45.67)), female patients (OR = 23.50 (95%CI: 1.48 – 374.40)) and homogeneous lesion (OR = 26.93 (95%CI: 1.96 – 370.66)) were reported to have higher likelihood of indicating the need for yellow/brown spot transformation during the resin infiltration treatment procedure.

A clinical case report

A 16-year-old Vietnamese female patient presented with the chief complaint of dentin hypersensitivity, difficulty in mastication, and discoloration in her upper right first central incisor since its eruption. Her mother did not remember if she had any special medical problems during pregnancy. There were also no special medical problems in the first 3 years after birth. The patient and her family lived in a non-fluoridated area.

Intraoral clinical examination in the wet condition showed a white demarcated opacity observed in the upper right first central incisor. Using the EP Light and O-Star curing light for dental transillumination, the dental practitioner identified a rectangular defect with a thin line at each corner, making the lesion resemble a star. Intraoral photographs were captured by a 105mm NIKON camera (Figure 5A). The clinical characteristics of the hypomineralized defect led to the diagnosis of MIH.

After treatment, the patient reported an absence of dentin hypersensitivity, no masticatory problems, and no discoloration in the affected tooth. No defects were found in both transilluminated and reflected intraoral images (Figure 5B). In this case report, the resin infiltration technique was applied regarding the maxillary central incisor, resulting in an aesthetically satisfactory outcome.

DISCUSSION

First, regarding the relationship among clinical parameters of the MIH lesions (Table 1) and the risk analysis in Table 2 for diagnosis improvement, our study found that there was a significant association between the lesion color and the rate of developing ECL and PEB. In more detail, colored lesions were reported to have a much higher risk of developing these surface integrity damages (13 times). This could be understandable as yellow/brown opacities had been scientifically proven to be softer[21] and more porous[22] than their non-colored counterparts, resulting in the reduction of the mineral density and thus, the mechanical properties of affected teeth were also greatly decreased,[21] facilitating the appearance of ECL or PEB. By this, our result corresponds with the previous research from Tunisia,[23] Australia,[24] Brazil[21] and New Zealand.[22]

Furthermore, although there was a lack of statistical significance, size I lesion was still observed for the highest rates of both ECL and PEB (Table 1). To our knowledge, this result contrasted many previous studies[23,25] about MIH, and there had not been a study that reported similar results. We hypothesized that there was a crucial variable regarding the development extent of MIH that could be easily neglected, namely the lesion depth. Size I could show the lowest mesiodistal extent of the lesion; however, the anterior-posterior extent had received inadequate attention, possibly leading to the misunderstanding of the damage severity. This could be further alarmed by acknowledging the fact that the mineral density gradient had been proven to decrease from enamel surface to DEJ for MIH-affected teeth,[24] in which the lesion could easily spread deeply under the enamel surface and result in extensive destruction. Therefore, our study poses the need to include lesion depth into the diagnostic criteria in future studies. One feasible technique regarding this issue is to use transillumination.[23]

Another interesting noticeable factor was that females had a lower risk of developing the colored lesions but showed a higher risk of having ECL or PEB lesions, all of which were statistically significant. Higher colored lesion risks in males could be explained by knowing the fact that females tend to have a greater interest in oral and general health,[26] thereby facilitating their oral hygiene practice and reducing the likelihood of having the colored lesion. However, given that colored lesions had been shown to increase the risk of ECL/PEB, the aforementioned demonstration might not be correct when it comes to comparing different sexes. This raises a question about whether specific hormones related to sex might play a role in this irony, which should be thoroughly assessed in further research.

In the study, the age range with the cut point of 11 years old was used as a variable because the age of 11 years indicated the period that there was the root completion in incisors[27] – the major type of teeth that MIH lesions for anterior teeth were observed for. However, we found no statistical significance, although the fact that the higher proportion of PEB was seen for patients at the age of or under 11 years old should be noted.

Considering factors impacting on the treatment modality using resin infiltration, PEB lesions required the lowest etching cycles (roughly more than 4 cycles), as post-eruptive breakdown indicated the severe damage of MIH resulting in seriously affected enamel damage after tooth eruption.[8] As a result, the enamel surface had been broken down with the decreased mineral density, leading to the lower number of etching cycles to approach the lesion and thereby reducing the time needed for the treatment. Moreover, in general, we can see that more Opalustre cycles for microabrasion required lower etching cycles. This could be understandable by acknowledging the fact that the access depth from Opalustre was significantly higher than etching,[28] thereby for deep MIH-related lesions, the higher number of Opalustre cycles could reduce the unnecessary etching cycles in the subsequent stages and lower the treatment time for both doctors and patients.

Besides, with regard to the need for yellow/brown spot transformation using 5% sodium hypochlorite, colored lesions are more likely to require spot transformation, which was simply explanatory by acknowledging that spot transformation could help facilitate the post-operative aesthetic appearance of the colored lesions. Females were also reported to have a higher likelihood of using spot transformation, as females often showed greater interest in both oral and general health,[26] and presented with a higher attention level to beauty and aesthetics. And lastly, homogenous lesions were also more likely to demonstrate a higher need of spot transformation compared to the heterogeneous ones, as the homogeneous lesions were usually associated with the more severe destruction of the MIH lesions,[15] thereby increasing the porosity of the affected enamel, reducing the mineral density and mechanical properties and increasing the likelihood of staining as mentioned above.

Nevertheless, our study still faced a number of challenges and limitations. First, the sample size of our study was relatively small. Therefore, a number of diagnostic features according to the classification and factors regarding treatment procedures might not be appropriately evaluated. As a result, this was considered a pilot study that assessed the feasibility of conducting the research with a larger sample size, longer treatment period, and increased variability of study subjects. Next, data errors regarding treatment procedures were occurrence due to dental practitioners' competence, lesion difficulty management, and the lack of cooperation from the patients. More importantly, data errors could also happen regarding standardized photographs. Therefore, the training process with specific quality evaluation needs to be thoroughly carried out in future studies.

CONCLUSION

Lesion color, size, and sex are significant factors for evaluating the rate of enamel craze lines (ECL) and post-eruptive breakdown (PEB), as well as assessing the probability of developing these surface integrity damage in the near future regarding MIH-affected permanent anterior teeth. Moreover, in terms of the treatment process for these MIH lesions with resin infiltration, a lower number of etching cycles were needed for PEB, composite fillings were crucial after treatment for MIH lesions spotted in the sound enamel surface, and colored spot transformation using 5% sodium hypochlorite was required for colored, homogeneous lesions and female patients. Therefore, dental practitioners need to consider these factors carefully to guarantee a comprehensive approach and intervention for patients aesthetically affected by MIH.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Bekes K. Molar incisor hypomineralization: A clinical guide to diagnosis and treatment. Springer Cham; 2022.
2. Cook C, Moreno Lopez R. Is molar incisor hypomineralisation (MIH) a new disease of the 21st century? Pediatr Dent J. 2022; 32(2):67-76.
3. K Kühnisch J, Lauenstein A, Pitchika V, McGlynn G, Staskiewicz A, Hickel R, Grupe G. Was molar incisor hypomineralisation (MIH) present in archaeological case series? Clin Oral Investig. 2016; 20(9):2387-93.
4. Garot E, Couture-Veschambre C, Manton D, Beauval C, Rouas P. Analytical evidence of enamel

hypomineralisation on permanent and primary molars amongst past populations. Sci Rep. 2017; 7(1):1712.
5. Weerheijm KL, Jälevik B, Alaluusua S. Molar-incisor hypomineralisation. Caries Res. 2001; 35(5):390-1.
6. Koch G, Hallonsten AL, Ludvigsson N, Hansson BO, Holst A, Ullbro C. Epidemiologic study of idiopathic enamel hypomineralization in permanent teeth of Swedish children. Community Dent Oral Epidemiol. 1987; 15(5):279-85.
7. Vo TNN, Hoang BD. Association between molar-incisor hypomineralization (MIH) and primary teeth trauma, early loss of primary teeth among 12- to 15-year-old students in some provinces in Vietnam. Vietnam Med J. 2021;502(1). https://doi.org/10.51298/vmj.v502i1.544
8. Lygidakis NA, Garot E, Somani C, Taylor GD, Rouas P, Wong FSL. Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): An updated European Academy of Paediatric Dentistry policy document. Eur Arch Paediatr Dent. 2022; 23(1):3-21.
9. Manton DJ, Crombie FA, Silva MJ. The pathogenesis and aetiology of MIH: more questions than answers. In: Bekes K, editor. Molar Incisor Hypomineralization: A clinical guide to diagnosis and treatment. Springer International Publishing; 2020. pp. 33-44.
10. Silva MJ, Scurrah KJ, Craig JM, Manton DJ, Kilpatrick N. Etiology of molar incisor hypomineralization - A systematic review. Community Dent Oral Epidemiol. 2016; 44(4):342-53.
11. Weerheijm KL, Duggal M, Mejàre I, Papagiannoulis L, Koch G, Martens LC, Hallonsten AL. Judgement criteria for molar incisor hypomineralisation (MIH) in epidemiologic studies: A summary of the European meeting on MIH held in Athens, 2003. Eur J Paediatr Dent. 2003; 4(3):110-3.
12. Ghanim A, Elfrink M, Weerheijm K, Mariño R, Manton D. A practical method for use in epidemiological studies on enamel hypomineralisation. Eur Arch Paediatr Dent. 2015; 16(3):235-46.
13. Allam E, Ghoneima A, Kula K. Definition and scoring system of molar incisor hypomineralization: A review. Dent Oral Craniofac Res. 2017; 3:1000197.
14. Steffen R, Krämer N, Bekes K. The Würzburg MIH concept: the MIH treatment need index (MIH TNI): A new index to assess and plan treatment in patients with molar incisior hypomineralisation (MIH). Eur Arch Paediatr Dent. 2017; 18(5):355-61.
15. Marouane O, Manton DJ. The use of transillumination in mapping demarcated enamel opacities in anterior teeth: A cross-sectional study. Int J Paediatr Dent. 2022; 32(1):49-55.
16. Perdigão J. Resin infiltration of enamel white spot lesions: An ultramorphological analysis. J Esthet Restor Dent. 2020; 32(3):317-24.
17. Bhandari R, Thakur S, Singhal P, Chauhan D, Jayam C, Jain T. Concealment effect of resin infiltration on incisor of Grade I molar incisor hypomineralization patients: An in vivo study. J Conserv Dent. 2018; 21(4):450-4.
18. Tirlet G, Chabouis HF, Attal JP. Infiltration, a new therapy for masking enamel white spots: A 19-month follow-up case series. Eur J Esthet Dent. 2013; 8(2):180-90.
19. Bulanda S, Ilczuk-Rypuła D, Dybek A, Pietraszewska D, Skucha-Nowak M, Postek-Stefańska L. Management of teeth affected by Molar Incisor Hypomineralization using a resin infiltration technique—a systematic review. Coatings. 2022; 12(7):964.
20. Ericson D. The concept of minimally invasive dentistry. Dent Update. 2007; 34(1):9-10, 12-4, 17-8.
21. Da Costa-Silva CM, Ambrosano GM, Jeremias F, De Souza JF, Mialhe FL. Increase in severity of molar-incisor hypomineralization and its relationship with the colour of enamel opacity: A prospective cohort study. Int J Paediatr Dent. 2011; 21(5):333-41.
22. Farah R, Drummond B, Swain M, Williams S. Linking the clinical presentation of molar-incisor hypomineralisation to its mineral density. Int J Paediatr Dent. 2010; 20(5):353-60.
23. Marouane O, Chtioui F. Transillumination-aided infiltration: A diagnostic concept for treating enamel opacities. J Esthet Restor Dent. 2020; 32(5):451-6.
24. Gambetta-Tessini K, Mariño R, Ghanim A, Adams GG, Manton DJ. Validation of quantitative light-induced fluorescence-digital in the quantification of demarcated hypomineralized lesions of enamel. J Investig Clin Dent. 2017; 8(4):12259.
25. Jälevik B. Prevalence and diagnosis of Molar-Incisor- Hypomineralisation (MIH): A systematic review. Eur Arch Paediatr Dent. 2010; 11(2):59-64.
26. Ostberg AL, Halling A, Lindblad U. Gender differences in knowledge, attitude, behavior and perceived oral health among adolescents. Acta Odontol Scand. 1999; 57(4):231-6.
27. Nelson SJ. Wheeler's Dental Anatomy, Physiology, and Occlusion. 10th ed. St. Louis, MO: Elsevier; 2015.
28. Tam CP, Manton DJ. Aesthetic Management of Molar Incisor Hypomineralization: Staged Strategies for Affected Incisors. In: Bekes K, editor. Molar Incisor Hypomineralization: A clinical guide to diagnosis and treatment. Springer International Publishing; 2020. pp.167-86.

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