Submitted: 11 August, 2023 Accepted: 12 September, 2023 Published: 03 May, 2024 DOI:10.22514/jocpd.2024.061

ORIGINAL RESEARCH

Journal of Clinical Pediatric Dentistry

Management of severity lesions of hypomineralized molars (MIH) with different treatment alternatives: 9-month results of a clinical trial

Mine Ozsoy[1], Ozge Erken Gungor[1,*]

[1]Department of Pediatric Dentistry Antalya, Akdeniz University Faculty of Dentistry, 07058 Antalya, Turkey

***Correspondence**
ozgegungor@akdeniz.edu.tr
(Ozge Erken Gungor)

Abstract

The aim of this study was to evaluate the 9-month clinical performance of different materials and treatment procedures in teeth with MIH in children, and to evaluate the effectiveness of Papacarie gel as a deproteinization agent. The study included 90 children (aged 8–15) who had 189 first permanent molars with MIH were restored randomly with 4 different materials/methods. Equia Forte HT (GC, Tokyo, Japan) was used in Group 1; In Group 2, G-eanial composite (GC, Tokyo, Japan) was used with a Fuji IX (GC, Tokyo, Japan) base; In Group 3 and Group 4, EverX Posterior (GC, Tokyo, Japan) base and G-eanial composite (GC, Tokyo, Japan) were used. In group 4, deproteinization was performed with Papacarie Duo gel (F&A, Sao Paulo, Brazil). The restorations were evaluated at 3-month intervals for 9 months using modified United States Public Health Service (USPHS) criteria. The overall recall rate was 94.1% for every 3-month clinical evaluation over 9 months. A total of 9 restorations were unsuccessful. Surface roughness of Group 1 was statistically different from all other groups in all control periods ($p < 0.05$). Marginal adaptation of Group 2 was found to be significantly different from Groups 3 and 4 at the both of 6th and 9th month controls. There was no significant difference between the groups in terms of retention, color match, marginal discoloration and secondary caries in all control months. Restoration of MIH with Equia Forte HT is almost as successful as composites. The use of dentin replacement materials instead of glass ionomer cements as a base in composite restorations shows better results. Papacarie deproteinization showed similar success with other composite groups. This study was the first clinical study in which Papacarie was used for deproteinization in teeth with MIH and will thus contribute to the literature.

Keywords

Equia Forte HT; EverX posterior; Deproteinization; MIH; Papacarie

1. Introduction

Molar incisor hypomineralization (MIH) is a developmental defect characterized by lack of mineralization in which one or more permanent first molars, and often the incisors, are affected [1]. Its etiology is unknown as yet, though it is considered multifactorial. The prevalence of MIH varies between 2% and 40% worldwide [2].

Teeth affected by MIH show enamel opacities ranging from white to brown, depending on the severity of the hypomineralization [1]. Tooth brushing or chewing forces can cause posteruptive impairment, in turn causing sensitization. In cases where the dentin is exposed, sensitivity to dental caries begins [2–4].

The prisms in enamel affected by MIH are irregular and have a porous structure. Besides, the strength and hardness of the enamel impairs due to the low mineral content. These features constitute risk factors for rapid caries development and restoration failures [5]. Children affected by MIH are obliged to undergo dental treatment of their first molars nearly 10 times as often as healthy children [6].

Although there are various treatment options, there is no consensus on the most effective treatment method. The severity of the defects, whether the affected tooth is symptomatic, the patient's dental age, and the child/parent's expectations should be considered as deciding on the treatment method in MIH [7]. Restoration of teeth with MIH is difficult owing to the excess tissue loss. Therefore, it is necessary to use materials that are resistant to chewing forces [8].

Enamel with MIH has less mineral content and quality (lower calcium and phosphorus content) and a lower modulus of hardness and elasticity than healthy enamel; however, the protein content, carbon and carbonate concentrations are higher [9–11].

Adhesives have a lower bonding ability to the tooth surface because of the mineral deficiency caused by the higher organic

content in hypomineralized tooth enamel [5]. Therefore, it is necessary to remove excess protein before using adhesives [12]. However, there are also studies that claim that deproteinization is not very effective in adhesion [13, 14].

The process of removing excess protein in the enamel is called deproteinization. The 5% formulation of sodium hypochlorite (NaOCl) solution is commonly employed for this objective. NaOCl is a non-specific proteolytic alongside antibacterial effects. However, free radicals are released as a by-product of the collagenolytic action of NaOCl, and residual radicals on the dentin surface are thought to impair the polymerization of adhesives. Since NaOCl is a strong oxidizing agent and can affect oral soft tissues, especially in young children, it would be beneficial to use an alternative deproteinizing agent such as Papacarie gel [15]. Papacarie is a natural papain-based gel extracted from ripe green papaya fruits and leaves [16]. It has antibacterial, proteolytic and anti-inflammatory properties and has therefore been used in the chemomechanical removal of caries [17]. The proteolytic effect of Papacarie has made it used as an effective deproteinization agent to increase enamel adhesion [18].

Papacarie is used in gel form for deproteinization and no study in the medical literature has yet inquired into its use and effectiveness in MIH. The aim of this study was to evaluate the 9-month clinical performance of different materials and treatment procedures in teeth with MIH in children, and to evaluate the effectiveness of Papacarie gel as a deproteinization agent for the restoration of teeth with MIH.

2. Material and methods

2.1 Study setting

This study was conducted at Akdeniz University Faculty of Dentistry Pediatric Dentistry Clinic, involving children with a healthy constitution aged between 8–15 years who applied for routine dental treatments.

2.2 Study patients

Children diagnosed with MIH during their routine dental treatment with no comorbidity composed the study population.

Power analysis was performed to determine the number of teeth to be included in the study. The sample size was determined as 172 teeth, with 43 teeth in each group, as a result of the power analysis.

The study included 90 patients (53 girls and 37 boys) who had MIH in their molars and needed treatment. In total, 189 teeth were treated randomly with four different materials/methods. The teeth were first divided into four groups (2b, 2c, 4b, 4c) based on the MIH Treatment Need Index (MIH TNI), and then randomly assigned to treatment groups.

2.2.1 Inclusion criteria

- Patients with tooth to be treated because of MIH.
- Teeth with 2b, 2c, 4b and 4c scores according to the MIH Treatment Index (MIH-TNI) [19].
- Aged between 8–15 years was added.

2.2.2 Exclusion criteria

- Abscess and/or fistula formation
- Percussion, palpation sensitivity or awakening due to pain at night
- Mobility and pathological gingival pockets
- Pulp treatment for caries or other reasons
- Patients with comorbidities
- Denied to give inform consent

2.3 Clinical examination

Medical anamnesis obtained from the parents included gestational age during birth, birth weight, cesarean delivery, parental education status, and frequent antibiotic use in the first years of life. Besides, any complication during pregnancy, duration of breastfeed, drug use and any disease during pregnancy were also recorded as well as the dental examination findings.

International Caries Detection and Assessment System (ICDAS) II criteria were used in order to determine the general caries statuses for all teeth. Also, any molar teeth with MIH that needed treatment were identified.

2.4 Clinical applications

Intraoral examinations of the patients were conducted using a mirror and a probe under the aid of reflector light. All dental procedures were performed under local anesthesia by the same clinician. The cavity entrance was performed by using a diamond round bur using a high-speed, water-cooled with aerator, and the cavity edges were smoothed with a diamond fissure bur. Carious dentin tissue was removed with a steel round bur using a low speed with micromotor. Hypomineralized areas at the cavity edges were included in the cavity. Hypomineralized areas that were neither destroyed nor associated with the cavity were excluded. After the cavity preparation was completed, the teeth were isolated with a rubber dam (Royal Shield Powder Free Latex Dental Dams, Malaysia). Direct/indirect capping was performed using Therecal LC (Bisco, USA) in teeth with deep dentin caries requiring capping. The procedures were consistently applied in the same manner across all groups up this stage.

2.4.1 Group 1: Equia Forte HT

An Equia Forte HT (GC, Tokyo, Japan) capsule was placed in an automatic mixer and stirred for 10 s. The capsule was then placed in a special applicator and injected into the cavities. After the manufacturer's recommended setting time of 2.5 minutes, the restoration was ended up, polished and gently dried. Equia Forte Coat (GC) was applied to the restoration surfaces and cured for 20 s.

2.4.2 Group 2: Fuji IX + Clearfil SE Bond + G-eanial composite

After the cavity was prepared and the tooth was isolated, the glass-ionomer cement (GIC) Fuji IX (GC, Tokyo, Japan) was hand-mixed and inserted in the cavity as a baseline thorough the manufacturer's recommendations. The cavity walls were cleaned with an excavator, and Clearfil SE Bond (Kuraray

Medical, Okayama, Japan) was applied to the cavity per the manufacturer's recommendations. G-eanial posterior composite GC, Tokyo, Japan) was placed on the prepared surface in layers of a maximum of 2 mm per the manufacturer's recommendations, and each layer was polymerized for 20 s with Light emitting diode (LED) unit (VALO, Ultradent, South Jordan, Utah, USA, ABD). Polymerization was performed again for 20 s after removing the matrix and wedges. The finishing and polishing procedures were conducted using yellow belt diamond finishing burs and yellow rubber burs in the same session after the height control was performed with an articulation paper.

2.4.3 Group 3: Clearfil SE Bond + EverX Posterior composite + G-eanial composite

Having prepared the cavity and isolated the tooth, Clearfil SE Bond (Kuraray Medical, Okayama, Japan) was applied to the cavity per the manufacturer's recommendations. After the primer was applied for 20 s and dried slightly with air-water spray, the bond was applied, dried slightly with air-water spray, and polymerized for 10 s. The fiber-reinforced composite EverX Posterior (GC, Tokyo, Japan); was placed into the cavity with an approximate of 4-mm thickness. The last 2 mm of the cavity were restored using the G-aenial Posterior composite as an overlay layer. Each increment was light-cured for 20 s using the same LED unit (VALO, Ultradent, Utah, ABD). The finishing and polishing procedures were the same as in Group 2.

2.4.4 Group 4: Papacarie Duo gel +Clearfil SE Bond + EverX Posterior composite + G-eanial composite

Having prepared the cavity and isolated the tooth, Papacarie gel (Papacarie Duo, F&A Pharmaceutical Laboratory Ltd, Sao Paulo, Brazil) was applied into the cavity for 60 s through the manufacturer's recommendations in order to accomplish deproteinization. First, the gel was removed from the cavity with the help of cotton pellets, and it was thoroughly washed with air-water spray for 15–20 s and dried. Clearfil SE Bond (Kuraray Medical, Okayama, Japan) was applied to the cavity per the manufacturer's recommendations. The fiber-reinforced composite EverX Posterior (GC, Tokyo, Japan) was placed into the cavity with approximately 4-mm thickness. The last 2 mm of the cavity were restored using the G-aenial Posterior composite as an overlay layer. Each increment was light-cured for 20 s using the same LED unit (VALO, Ultradent, Utah, ABD). The finishing and polishing procedures were the same as in Group 2.

2.5 Follow-up periods

The restorations were evaluated at 3-month intervals for 9 months using modified USPHS criteria for retention, marginal adaptation (This refers to the marginal fit of the restoration), marginal discoloration, secondary caries (This refers to decay that occurs around the restoration), surface roughness (This refers to the surface finish of the restoration) and color match by a blinded and calibrated examiner.

2.6 Statistical analysis

The study data were analyzed in SPSS (Statistical Package for the Social Sciences, IBM, Armonk, NY, USA) 23.0 and MedCalc (MedCalc Software bvba, Mariakerke, East Flanders, Belgium) 23.110. Numeric data were expressed as mean ± standard deviation or median (interquartile range (IQR)) and frequent data as rates. Comparison of two independent groups with numeric data was carried out by Mann Whitney U test. Kruskal Wallis test was used so as to compare three or more groups with ordinal data. Besides, comparison of three or more groups with frequent data was performed by Chi-square test. *Post-hoc* analysis of Chi-square test was performed by Bonferroni Chi-square Residual Analysis and by Conover test after Kruskal Wallis as well. The normality analysis was conducted by Kolmogorov Smirnov test and Spearman's Rho correlation coefficient was used to ascertain the correlation between two groups.

All the hypotheses were constructed as two-tailed and an alpha critical value of 0.05 was accepted as significant.

3. Results

3.1 Evaluation of demographic data

A total of 90 children diagnosed to have MIH of molar teeth was included into the study. Fifty-three (58.9%) of study patients were girls and 37 (41.1%) were boys. The mean age of the study patients was 9.3 ± 1.7 years.

Only a minor part of the parents had a bachelor degree and this was also true for mothers (n = 19; 21.1%) and fathers (n = 22; 24.4%) alike (Table 1). Only 16.7% of study patients used antibiotic till 5 years old. Most of the study patients had a history of term gestation (n = 86, 95.6%), normal birth weight (n = 83, 92.2%) and 51.1% (n = 46) of them was born with cesarean section. 15.6% (n = 14) of patients had been breastfed less than six months, 26.7% (n = 24) for 6–12 months, 48.9% (n = 44) for 1–2 years and 8.9% (n = 8) of them over 2 years. The demographic data of the study patients was displayed in Table 2.

TABLE 1. The educational status of parents.

	Mother (N%)	Father (N%)
Illiterate	4.4%	1.1%
Primary school	38.9%	36.7%
High school	35.6%	37.8%
University	21.1%	24.4%

Although the median number of teeth with MIH is higher in patients with term gestation (5 (The interquartile range (IQR): 4–7) *vs.* 3 (IQR: 3–3.5)), without disease in pregnancy (5 (IQR: 3–7) *vs.* 3 (IQR: 2–5.5)) and with normal birth weight (5 (IQR: 4–7) *vs.* 3 (IQR: 3–4)), there was no statistically significant difference in those demographic variables and the remaining (Table 3).

TABLE 2. Prenatal and postnatal etiological factors for patients with MIH.

Prenatal and postnatal variables	N (%)
Gestation period	
Preterm	4.4
Term	95.6
Postterm	0
Disease during gestation	4.4
Medication during gestation	12.2
Delivery method	
Natural childbirth	48.9
Cesarean section	51.1
Birth complication	2.2
Birth weight	
Low	7.8
Normal	92.2
High	0
Breastfeeding duration	
0–6 mon	15.6
6 mon–1 yr	26.7
1–2 yr	48.9
More than 2 yr	8.9

TABLE 3. The relationship between median number of teeth with MIH and pre/postnatal etiological factors.

Variables	Total number of teeth with MIH (IQR)	*p* value
Gestation period		
Preterm	3.00 (3.00–3.50)	0.06
Term	5.00 (4.00–7.00)	
Disease during gestation period		
Yes	3.00 (2.00–5.50)	0.24
No	5.00 (3.00–7.00)	
Drug administration during gestation period		
Yes	5.00 (2.50–5.75)	0.50
No	5.00 (3.00–7.00)	
Delivery method		
Natural	4.50 (3.00–6.00)	0.46
Ceserian	5.00 (4.00–7.00)	
Birth weight		
Low	3.00 (3.00–4.00)	
Normal	5.00 (4.00–7.00)	0.08
High		
Breastfeeding duration		
0–6 mon	5.50 (5.00–7.00)	
6 mon–1 yr	4.50 (3.00–6.00)	0.10
1–2 yr	5.00 (4.00–7.00)	
More than 2 yr	3.50 (3.00–5.50)	

IQR: Interquartile range.

3.2 Evaluation of dental data

At least one incisor and three molar teeth were affected by MIH in the same patient. There was no correlation between the patients' medical histories of preterm birth, low birth weight, cesarean delivery, parental education status and frequent antibiotic use in the first years of life and their ICDAS II scores. There was a very weak correlation between the mean ICDAS II score and the total number of teeth with MIH ($r = 0.21$; $p = 0.04$).

An average of two molar teeth with MIH were restored in each patient. The overall recall rate was 94.1% for every 3-month clinical evaluation over 9 months. According to the modified USPHS criteria, teeth with retention loss and/or secondary caries category Charlie and/or teeth that have been retreated for pulpal reasons are considered to be failures/unsuccessful. At the end of the study, a total of nine restorations were unsuccessful. Three of these failures were due to pulpal causes, five due to loss of retention, and one due to secondary caries. Of the restorations that failed due to pulpal causes, two belonged to Group 1 (one was at the 3rd month and the other was at the 6th month), one belonged to Group 2 (at the 6th month). Four of the restorations with loss of retention belonged to Group 1 (two were at 3rd month, one was at the 6th month, and the other was at the 9th month), one belonged to Group 3 (at the 3 month). One restoration that failed due to secondary caries belonged to Group 4 (at the 9 month). The results of the clinical examination scores according to modified USPHS criteria are shown in Table 4.

Also, 2 restorations in Group 1, 4 restorations in Group 2, 1 restoration in Group 3, and 6 restorations in Group 4 could not be checked because the patients did not attend the 3-month follow-up appointment. Three restorations in Group 2, 1 restoration in Group 3, and 2restorations in Group 4 could not be checked because the patients did not attend the 6-month follow-up appointment. Two 2 restorations in Group 1 could not be checked because the patients did not attend the 9-month follow-up appointment. The survival rates of the restorations at the end of the 9th month were as follows: 87.6% for Group 1, 97.6% for Group 2, 97.7% for Group 3, and 97.3% for Group 4 (Fig. 1).

4. Discussion

Children with teeth affected by MIH may not be able to brush their teeth adequately due to the sensitivity of these teeth. So, this may increase ICDAS II scores. This study showed the number of teeth with MIH does not differ significantly among the demographic variables. This is also true for ICDAS II score. There is no study in the medical literature evaluating the relationship of MIH and ICDAS II score with the demographic variables. Accordingly, it is not possible to compare the data of the present study with the other studies. Further studies are needed to verify the findings of the current study, whether there is a difference in the number of teeth with MIH and ICDAS II scores, considering the demographic variables. Jälevik *et al.* [6] reported that the restored MIH teeth needed for restoration renewal were two times higher than the normal teeth; on the other hand, Kotsanos *et al.* [7] reported that this ratio three

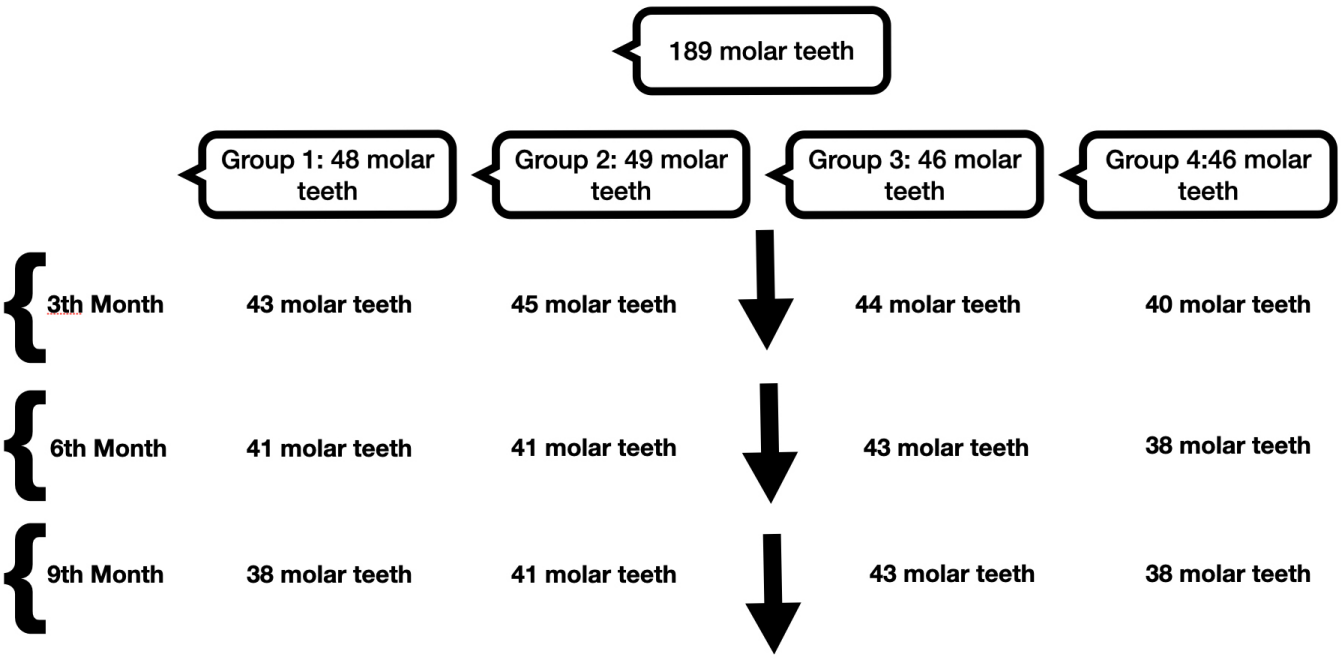

FIGURE 1. Figure showing the change in groups over three-month periods.

times on average. The need for repeated treatment is thought to be because of a deterioration in the connection between the restoration and the tooth tissue [6, 20].

In this study, four out of five restorations considered unsuccessful due to retention loss which belonged to the high viscosity glass ionomer (HVGIC) group. This result is consistent with other studies which also reported that composite resin restorations showed up better results in defective permanent first molars [20–22].

There are limited studies in the literature on the use of GIC in teeth with MIH [8, 23, 24]. The study by Grossi *et al*. [8] removed caries with the Atraumatic Restorative Treatment (ART) technique in teeth with MIH and restored them with Equia Forte HT. They achieved a survival rate of 98% after 12 months of restorations. A previous study, in 2014, by Fragelli *et al*. [24] restored the teeth with MIH with a hand-mixed GIC and reported a success rate of 78% at the end of 12 months. Lastly, Durmus *et al*. [23] restored 134 permanent first molars in 58 patients with MIH in 2020 using the selective caries removal method by Equia Forte and reported the 24-month survival rate as 87.5%. In the current study, the survival rate at the end of the 9 months for Equia Forte HT was 86.3%.

This study included teeth with 2b, 2c, 4b and 4c scores according to MIH-TNI, as well as teeth with moderate and severe destruction. Thereby, traditional GIC was used as the base material in the composite group. EverX Posterior was utilized as the base material in the two remaining composite groups. Restorations in Groups 3 and 4, employing EverX Posterior as a base, demonstrated superior marginal adaptation compared to the restorations in Group 2, which employed a GIC base. Existing literature suggests that the use of GIC bases yields less favorable outcomes compared to base materials containing resin [25–27]. The findings of the present study are consistent with the current literature.

Many studies showed that NaOCl deproteinization increases adhesive bonding [15, 28–30]. On the other hand, suggestions have been made that use of an alternative deproteinization agent would be more beneficial on the grounds that NaOCl may impair the polymerization of adhesives by releasing free radicals. As a strong oxidizing agent, NaOCl demands cautious application to avoid potential adverse effects on oral soft tissues, particularly in young children [15].

In vitro studies of deproteinization with Papacarie in teeth with healthy enamel [31–33] and enamel affected by MIH [15, 34, 35] reported increased adhesive bonding. Previous studies reported Papacarie as an alternative agent to NaOCl for deproteinization in MIH, though they were all conducted *in vitro* and thereby indicating the need for *in vivo* investigations, particularly in human subjects [15, 34, 35].

Composite resins are more successful than GIC as restorative materials in the treatment of teeth affected by MIH. The results of this study also supported this information. The most unsuccessful of the three composite groups in this study was the GIC base group. It is better to use a biomimetic dentin replacement material instead of GIC as a base under composite resins with or without deproteinization.

When the Papacarie deproteinized group was compared with the other composite groups that were not deproteinized, it turned up to be more successful than the GIC base group in terms of edge compliance, and it showed similar results with the EverX base group without deproteinization. Deproteinization with Papacarie has provided a great advantage in cases where anesthesia is insufficient in teeth affected by MIH because it also helps to chemomechanically remove caries in clinical practice.

TABLE 4. Clinical evaluation of all groups at 3, 6 and 9 months.

	3th month					6th month					9th month				
	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Group 4 N (%)	*p* value	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Group 4 N (%)	*p* value	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Group 4 N (%)	*p* value
Retention															
Alfa	43 (95.6)	45 (100.0)	44 (97.8)	40 (100.0)	0.32	41 (97.6)	41 (100.0)	43 (100.0)	38 (100.0)	0.40	38 (97.4)	41 (100.0)	43 (100.0)	38 (100.0)	0.37
Charlie	2 (4.4)	0	1 (2.2)	0		1 (2.4)	0	0	0		1 (2.6)	0	0	0	
Marginal Adaptation															
Alfa	40 (93.0)	41 (91.1)	44 (100.0)	40 (100.0)	0.06	36 (87.8)	34 (82.9)	41 (95.3)	38 (100.0)	0.03*	29 (76.3)	30 (73.2)	39 (90.7)	36 (94.7)	0.02*
Beta	3 (7.0)	4 (8.9)	0	0		5 (12.2)	7 (17.1)	2 (4.7)	0		9 (23.7)	11 (26.8)	4 (9.3)	2 (5.3)	
Charlie	0	0	0	0		0	0	0	0		0	0	0	0	
Marginal Discolouration															
Alfa	42 (97.7)	44 (97.8)	43 (97.7)	40 (100.0)	0.82	41 (100.0)	40 (97.6)	42 (97.7)	37 (97.4)	0.79	38 (100.0)	39 (95.1)	41 (95.3)	37 (97.4)	0.57
Beta	1 (2.3)	1 (2.2)	1 (2.3)	0		0	1 (2.4)	1 (2.3)	1 (2.6)		0	2 (4.9)	2 (4.7)	1 (2.6)	
Charlie	0	0	0	0		0	0	0	0		0	0	0	0	
Secondary Caries															
Alfa	43 (100.0)	45 (100.0)	44 (100.0)	40 (100.0)	1.00	41 (100.0)	41 (100.0)	43 (100.0)	38 (100.0)	1.00	38 (100.0)	41 (100.0)	43 (100.0)	37 (97.4)	0.35
Charlie	0	0	0	0		0	0	0	0		0	0	0	1 (2.6)	
Surface Roughness															
Alfa	38 (88.4)	44 (97.8)	44 (100.0)	40 (100.0)	<0.001*	32 (78.0)	41 (100.0)	43 (100.0)	38 (100.0)	<0.001&	30 (78.9)	41 (100.0)	43 (100.0)	38 (100.0)	<0.001&
Beta	5 (11.6)	1 (2.2)	0	0		9 (22.0)	0	0	0		8 (21.1)	0	0	0	
Charlie	0	0	0	0		0	0	0	0		0	0	0	0	
Colour Match															
Alfa	42 (100.0)	45 (100.0)	44 (100.0)	40 (100.0)	0.39	39 (95.1)	41 (100.0)	42 (97.7)	38 (100.0)	0.30	36 (94.7)	41 (100.0)	42 (97.7)	38 (100.0)	0.27
Beta	1 (2.3)	0	0	0		2 (4.9)	0	1 (2.3)	0		2 (5.3)	0	1 (2.3)	0	
Charlie	0	0	0	0		0	0	0	0		0	0	0	0	

**: The post-hoc analysis found that there was a statistically significant difference between Group 1 and the other groups in terms of their average test scores ($p < 0.001$).*

&: In the post-hoc analysis, the p-value was not found to be below the Bonferroni-corrected alpha critical value ($p < 0.001$).

5. Conclusions

In the restorative treatment of molar teeth with MIH, it was concluded that composites are superior to glass ionomer cements, regardless of deproteinization. This study is the first clinical study to use Papacarie for deproteinization in teeth with MIH. This study also showed that Papacarie has a clinically beneficial effect on the removal of caries, in addition to deproteinization. In addition, the number of teeth with MIH and ICDAS II score do not differ among the demographic variables of the children diagnosed to have MIH.

AVAILABILITY OF DATA AND MATERIALS

All data generated or analyzed during this study are included in this published article.

AUTHOR CONTRIBUTIONS

MO and OEG—analyzing and interpreting the data and revising the study, contributed equally to the work.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was ethically approved with the decision of the Akdeniz University Faculty of Medicine Clinical Research Ethics Committee, dated 11 November 2020 and numbered 873. All participants and their parents were freely invited, and those who accepted signed and informed consent. The participants aged under 16, the written informed consent was signed by their parent or legal guardian.

ACKNOWLEDGMENT

The authors would like to express our gratitude to those who have critically reviewed this manuscript and those who gave us help during the experiment.

FUNDING

This project was supported by the Akdeniz University Scientific Research Projects Coordination Unit on 26 May 2021 (Project Number: TDH-2020-5280).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Restrepo M, Rojas-Gualdrón DF, de Farias AL, Escobar A, Vélez LF, Bussaneli DG, *et al*. Development of undergraduate students' diagnostic accuracy for the classification of molar incisor hypomineralization. To be published in European Journal of Dental Education. 2023. [Preprint].

[2] Bandeira Lopes L, Machado V, Botelho J, Haubek D. Molar-incisor hypomineralization: an umbrella review. Acta Odontologica Scandinavica. 2021; 79: 359–369.

[3] Cabral RN, Nyvad B, Soviero VLVM, Freitas E, Leal SC. Reliability and validity of a new classification of MIH based on severity. Clinical Oral Investigations. 2020; 24: 727–734.

[4] 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. European Archives of Paediatric Dentistry. 2022; 23: 3–21.

[5] Alzahrani AY, Alamoudi MMH, El Meligy OAES. Contemporary understanding of the etiology and management of molar incisor hypomineralization: a literature review. Dentistry Journal. 2023; 11:157.

[6] Jälevik B, Klingberg GA. Dental treatment, dental fear and behaviour management problems in children with severe enamel hypomineralization of their permanent first molars. International Journal of Paediatric Dentistry. 2002; 12: 24–32.

[7] Kotsanos N, Kaklamanos EG, Arapostathis K. Treatment management of first permanent molars in children with molar-incisor hypomineralisation. European Journal of Paediatric Dentistry. 2005; 6: 179–184.

[8] Grossi JA, Cabral RN, Ribeiro APD, Leal SC. Glass hybrid restorations as an alternative for restoring hypomineralized molars in the ART model. BMC Oral Health. 2018; 18: 65.

[9] Juárez-López MLA, Salazar-Treto LV, Hernández-Monjaraz B, Molina-Frechero N. Etiological factors of molar incisor hypomineralization: a systematic review and meta-analysis. Dentistry Journal. 2023; 11: 111.

[10] Enax J, Amaechi BT, Farah R, Liu JA, Schulze Zur Wiesche E, Meyer F. Remineralization strategies for teeth with molar incisor hypomineralization (MIH): a literature review. Dentistry Journal. 2023; 11: 80.

[11] Rodd HD, Graham A, Tajmehr N, Timms L, Hasmun N. Molar incisor hypomineralisation: current knowledge and practice. International Dental Journal. 2021; 71: 285–291.

[12] Lagarde M, Vennat E, Attal JP, Dursun E. Strategies to optimize bonding of adhesive materials to molar-incisor hypomineralization-affected enamel: a systematic review. International Journal of Paediatric Dentistry. 2020; 30: 405–420.

[13] Rolim TZC, da Costa TRF, Wambier LM, Chibinski AC, Wambier DS, da Silva Assunção LR, *et al*. Adhesive restoration of molars affected by molar incisor hypomineralization: a randomized clinical trial. Clinical Oral Investigations. 2021; 25: 1513–1524.

[14] Somani C, Taylor GD, Garot E, Rouas P, Lygidakis NA, Wong FSL. An update of treatment modalities in children and adolescents with teeth afected by molar incisor hypomineralisation (MIH): a systematic review. European Archives of Paediatric Dentistry. 2022; 23: 39–64.

[15] Ekambaram M, Anthonappa RP, Govindool SR, Yiu CKY. Comparison of deproteinization agents on bonding to developmentally hypomineralized enamel. Journal of Dentistry. 2017; 67: 94–101.

[16] Bussadori SK, Castro LC, Galvão AC. Papain gel: a new chemo-mechanical caries removal agent. Journal of Clinical Pediatric Dentistry. 2006; 30: 115–119.

[17] Hamama HH, Yiu CK, Burrow MF, King NM. Chemical, morphological and microhardness changes of dentine after chemomechanical caries removal. Australian Dental Journal. 2013; 58: 283–292.

[18] Hasija P, Sachdev V, Mathur S, Rath R. Deproteinizing agents as an effective enamel bond enhancer-an *in vitro* study. Journal of Clinical Pediatric Dentistry. 2017; 41: 280–283.

[19] 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). European Archives of Paediatric Dentistry. 2017; 18: 355–361.

[20] Fayle SA. Molar incisor hypomineralisation: restorative management. European Journal of Paediatric Dentistry. 2003; 4: 121–126.

[21] Lygidakis NA, Chaliasou A, Siounas G. Evaluation of composite restorations in hypomineralised permanent molars: a four year clinical study. European Journal of Paediatric Dentistry. 2003; 4: 143–148.

[22] Mejàre I, Bergman E, Grindefjord M. Hypomineralized molars and incisors of unknown origin: treatment outcome at age 18 years. International Journal of Paediatric Dentistry. 2005; 15: 20–28.

[23] Durmus B, Sezer B, Tugcu N, Caliskan C, Bekiroglu N, Kargul B. Two-year survival of high-viscosity glass ionomer in children with molar incisor hypomineralization. Medical Principles and Practice. 2021; 30: 73–79.

[24] Fragelli CMB, Souza JF, Jeremias F, Cordeiro Rde C, Santos-Pinto L. Molar incisor hypomineralization (MIH): conservative treatment management to restore affected teeth. Brazilian Oral Research. 2015; 29: 1–7.

[25] Manihani AKDS, Mulay S, Beri L, Shetty R, Gulati S, Dalsania R. Effect of total-etch and self-etch adhesives on the bond strength of composite to glass-ionomer cement/resin-modified glass-ionomer cement in the sandwich technique—a systematic review. Dental Research Journal. 2021; 18: 72.

[26] Jaberi Ansari Z, Panahandeh N, Tabatabaei Shafiei ZS, Akbarzadeh Baghban A. Effect of self-etching adhesives on the bond strength of glass-ionomer cements. Journal of Dentistry. 2014; 11: 680–686.

[27] Ismail HS, Ali AI, Mehesen RE, Garcia-Godoy F, Mahmoud SH. *In vitro* marginal and internal adaptation of four different base materials used to elevate proximal dentin gingival margins. Journal of Clinical and Experimental Dentistry. 2022; 14: e550–e559.

[28] Mathu-Muju K, Wright JT. Diagnosis and treatment of molar incisor hypomineralization. Compendium of Continuing Education in Dentistry. 2006; 27: 604–610.

[29] Venezie RD, Vadiakas G, Christensen JR, Wright JT. Enamel pretreatment with sodium hypochlorite to enhance bonding in hypocalcified amelogenesis imperfecta: case report and SEM analysis. Pediatric Dentistry. 1994; 16: 433–436.

[30] Sönmez H, Saat S. A clinical evaluation of deproteinization and different cavity designs on resin restoration performance in MIH-affected molars: two-year results. Journal of Clinical Pediatric Dentistry. 2017; 41: 336–342.

[31] Bayrak GD, Gurdogan-Guler EB, Yildirim Y, Ozturk D, Selvi-Kuvvetli S. Assessment of shear bond strength and microleakage of fissure sealant following enamel deproteinization: an *in vitro* study. Journal of Clinical and Experimental Dentistry. 2020; 12: e220–e226.

[32] Pithon MM, Ferraz Cde S, de Oliveira Gdo C, Pereira TB, Oliveira DD, de Souza RA, *et al*. Effect of 10% papain gel on enamel deproteinization before bonding procedure. The Angle Orthodontist. 2012; 82: 541–545.

[33] Agarwal RM, Yeluri R, Singh C, Munshi AK. Enamel deproteinization using papacarie and 10% papain gel on shear bond strength of orthodontic brackets before and after acid etching. Journal of Clinical Pediatric Dentistry. 2015; 39: 348–357.

[34] Kusumasari C, Abdou A, Tichy A, Hatayama T, Hosaka K, Foxton RM, *et al*. Effect of smear layer deproteinization with chemo-mechanical caries removal agents on sealing performances of self-etch adhesives. Journal of Dentistry. 2020; 94: 103300.

[35] Lee YL, Li KC, Yiu CKY, Boyd DH, Waddell JN, Ekambaram M. Bonding universal dental adhesive to developmentally hypomineralised enamel. The Journal of Adhesive Dentistry. 2021; 23: 513–525.

How to cite this article: Mine Ozsoy, Ozge Erken Gungor. Management of severity lesions of hypomineralized molars (MIH) with different treatment alternatives: 9-month results of a clinical trial. Journal of Clinical Pediatric Dentistry. 2024; 48(3): 68-75. doi: 10.22514/jocpd.2024.061.