

Silicon-rich technology combined with calcium for dentin hypersensitivity management in molar incisor hypomineralization

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To the Editor

In daily clinical practice, molar incisor hypomineralization (MIH) is currently present, being a challenge for dental professionals. Molar incisor hypomineralization is defined as a developmental disorder of dental enamel compromising the structure, aesthetics, and shape of the tooth. Additionally, MIH-affected teeth may present dentin hypersensitivity (DH), which may have a negative impact on a patient's quality of life [1]. There are many proposals for managing MIH, but without a standard protocol. Among the treatments for MIH, the use of fluoride has proven important in preventing cavities and somewhat contributing to the management of hypersensitivity. However, fluoride (F) is limited in its ability to incorporate minerals into structures affected by MIH [1]. A possible reason could be associated with the action of F ions on dental structures. F ions could substitute hydroxyl ions (OH) in the hydroxyapatite— $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$, and this substitution tends to reinforce the pre-existing hydroxyapatite structure (less solubility) [2, 3]. On the other hand, the exploration of substitution in phosphate ions (PO_4), also known as the site of bioactivity by silicon-containing compounds, has gained acceptance in recent decades [3–11] and could be particularly helpful in the management of MIH [3, 7]. Bioactive compounds containing silicon

can nucleate calcium and phosphate resulting in the formation of new biomimetic surface apatite layers [3–10].

A new silicon-dependent technology associated with toothpaste, known as REFIX, has proven effective in forming silicon-enriched hydroxyapatite in dental structures (enamel and dentin) under adverse conditions, such as in an acidified environment, during remineralization processes [4–8, 11]. Also, according to Athanasiadou et al., the association of REFIX toothpaste and the regenerating calcium booster gel could accelerate the process of mineral deposition compared to the others silicon-based technologies [7]. This mineral built by REFIX on teeth exhibits regenerative/protective properties against mineral loss [3–5, 11] and potentially improving the treatment of DH [3, 6–8]. However, not yet tested for reducing DH due to MIH.

We report a DH remission in patients with MIH who underwent a prophylactic protocol with a combination of REFIX silicon-based dentifrice and calcium booster called REFIX BOOSTER System—Dentalclean US LLC, USA (Si/Ca protocol) [6–8]. This system comprising two dental gels—Crystallizer silica/phosphate gel—gray color and Accelerator calcium gel—white color (Figure 1). This article is considered no experimental study on humans since the products are FDA approved. Besides all the ethical precepts were complied.

Patients with MIH were included in this study since the main complaint reported was DH. To assess the severity of DH, three-way tip to blow the patient's teeth with MIH and a visual analogue pain scale (VAS) was used as previously described [12]. After the patient's guardians signed the dental record and informed consents, which was used to inform and consent to the right to access information, the patients underwent an anamnesis and clinical examination, and MIH was observed. The Si/Ca protocol was carried out after the patients and their guardians received instructions on treatment both in the dental clinic office and at home (Figure 1).

The Si/Ca protocol includes the following: Step 1: A dappen dish was filled with equal amounts of crystallizer gel and accelerator gel; Step 2: After mixing the dental gels during 15 seconds, apply the mixture to the teeth surface and wait 1 minute to begin the reaction on the

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Figure 1: The affected molars (A) and incisors were treated with the Silicon-rich dentifrice associated with a calcium booster protocol. Step 1: A dappen dish was filled with equal amounts of crystallizer gel and accelerator gel (B); Step 2: After mixing the dental gels during 15 seconds, apply the mixture to the teeth surface and wait 1 minute to begin the reaction on the tooth surface (C); Step 3: To promote dental cleaning, a soft prophylaxis brush in slow rotation with mixed gels was used (D); Step 4: The patients were instructed to brush their teeth three times a day at home, applying small amounts of both dental gels directly to the toothbrush (E).

tooth surface; Step 3: To promote dental cleaning, a soft prophylaxis brush in slow rotation with mixed gels was used; Step 4: The patients were instructed to brush their teeth three times a day at home, applying small amounts of both dental gels directly to the toothbrush.

Each patient was instructed to attend three clinical sessions for treatment and follow-up with an interval of one week between the first and second session and three weeks between the second and third session.

Table 1 illustrates anamnesis, clinical examination, and patient reports before and after treatment. A pattern of carious lesions associated with insufficient brushing, as well as HD with cold, hot, sweet, air, and brushing teeth stimulus, was found in this study. A rapid and significant relief of hypersensitivity was also observed from the first session of the protocol application for all patients.

Molar incisor hypomineralization, a qualitative developmental enamel defect, has received increasing

attention in recent years, with a prevalence of 13% worldwide [13]. The current fluoride-dependent technologies have failed to incorporate minerals into the affected structure. Also, patients with MIH frequently present sensitive teeth, one of its most common consequences, even if their enamel is intact [1, 14]. In this study the Si/Ca protocol has been shown to be effective in reducing DH. This outcome is in line with literature that reported decrease in DH after using the REFIX Si/Ca protocol [7, 8]. REFIX dental technology is an acidified bioactive complex made from silica and phosphates. When in contact with dental tissues induced the formation of silicon-rich hydroxyapatite layers [3–5, 7, 11]. These newly formed minerals regenerate and reinforce demineralized dental structures [3–5, 7]. Since the patients reported immediate pain relief after Si/Ca protocol, it was assumed that the structural integrity of the MIH affected teeth has been significantly restored, with consequent reduction of DH.

Molar incisor hypomineralization-affected teeth are known for the imperfect formation of apatite crystals, resulting in incomplete or deficient formation of the tooth enamel structure [1]. Thus, the treatment to be employed on teeth affected by MIH should be based on the choice of materials with biomimetic characteristics. In clinical dentistry, biomimetics refers to the repair of affected dentition by mimicking the characteristics of a natural tooth in terms of appearance, biomechanical properties, and functional abilities [2, 3, 11]. In this sense, silicon-based technologies have demonstrated the ability to form a protective mineral shield over dentin, also known as an enamel-like layer, which is capable of obliterating dentin tubules and protecting the teeth [3–5, 7].

Molar incisor hypomineralization hypersensitivity can cause substantial discomfort, difficulty in the consumption of cold or hot food or drink, as well as inadequate oral hygiene, which may increase the risk of

Table 1: Anamnesis, clinical examination, and patients' reports

Patient/sex/age	Anamnesis	Clinical examination	Patients' report	VAS baseline	VAS 1st session	VAS 2nd session	VAS 3rd session
1/F/9	Cariogenic diet	MIH, dental caries	HD (cold, hot, sweet, air, and brushing teeth stimulus)	Very severe	Mild	Mild	No pain
2/M/11	Restrict diet	MIH, insufficient brushing	HD (cold, hot, sweet, air, and brushing teeth stimulus)	Severe	Mild	No pain	No pain
3/M/5	Cariogenic diet	MIH, dental caries	HD (cold, hot, sweet, air, and brushing teeth stimulus)	Severe	Mild	Mild	No pain
4/F/8	Cariogenic diet	MIH, insufficient brushing due to the use of a removable appliance	HD (cold, hot, sweet, air, and brushing teeth stimulus)	Severe	No pain	No pain	No pain

caries, and limitations to daily life [1, 14, 15]. The teeth with the MIH tend to reveal more tooth sensitivity than healthy teeth. Conditions such as having MIH and tooth sensitivity might have a negative impact on the oral health-related quality of life. In addition, more sensitivity to the stimulus was observed in the teeth with lower tooth maturity status and dental age [15]. In this setting, the young age of many patients may complicate dental treatment. The use of the Si/Ca protocol improved the patient's clinical and emotional condition since pain was no longer reported.

The treatment of MIH emphasizes the need for more awareness and effective preventive actions, addressing the lack of clear guidelines. Some therapies are recommended for the treatment of hypersensitivity, such as photobiomodulation, glass ionomer sealant, bioactive materials, and even pulp therapy [1]. However, mainly minimally invasive treatments have been studied for this purpose. An assertive decision should be based on bioactive materials [1], since these materials can form new mineral compounds containing hydroxyapatite in dental structures [3–5, 7, 9–11]. In this regard, the new Si/Ca protocol could be included in the guidelines for MIH-related hypersensitivity. Although the study is a report of 4 unique cases, which may be a limitation of the study, it is the first study in which this protocol was tested for reducing DH due to MIH. The application of cutting-edge bioactive materials for dental regeneration using silicon-based technologies for oral health care demonstrated highly promising outcomes since a pattern of rapid reduction in DH in MIH was observed after the use of the prophylactic Si/Ca protocol in all patients.

Finally, although promising results were found, the number of participants is a limitation of this study. Long-term randomized clinical studies are indicated to evaluate the effectiveness of the prophylactic Si/Ca protocol in reducing sensitivity in patients with MIH and consequently dental mineralization. Silicon bioactive material for dental regeneration seems to reduce the MIH hypersensitivity since the patients no longer reported pain after treatment.

Keywords: Dentin hypersensitivity, Molar incisor hypomineralization, Regeneration, Silicon, Tooth demineralization

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Author Contributions

Fernanda Valone Gorini – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Kelly Maria Silva Moreira – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.

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