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# Case Report: Applicability of sedation with nitrous oxide in the management of molar incisor hypomineralization in pediatric patients

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Patients with molar-incisor hypomineralization (MIH) may manifest tooth hfypersensitivity and difficulties in undergoing dental treatment, including fear, anxiety, and behavior problems in the dental office. Then, the objective of this study was to report a clinical case series using inhalation sedation with nitrous oxide and oxygen as a clinical strategy in the management of MIH pediatric patients during dental treatment. Pediatric patients and their legal guardians were properly informed and data were extracted from clinical charts. Six clinical cases were included, whose patients were between 8 and 12 years old. Of these, 4 were female. The indication of moderate sedation took into account the clinical difficulties related to patients with MIH, such as obtaining anesthesia and cooperation, in addition to odontophobia and dental anxiety. All patients were carefully examined to undergo the sedation technique, including medical history and previous experiences with nitrous oxide inhalation sedation, as well as the vital signs were properly evaluated before, during and after the procedures. The nitrous oxide concentration ranged between 30% and 60%. The procedures were restorative, endodontic or surgical (extractions). In general, the use of sedation contributed to the performance of dental procedures. The use of inhaled sedation helped in behavioral management and during the treatment, increasing the effectiveness of local anesthesia. Patients were cooperative for treatment, while no adverse effects or complications related to sedation were observed. Thus, for the patients in this case series, the use of inhalation sedation with nitrous oxide and oxygen contributed to the clinical management of patients with MIH.

KEYWORDS

inhalation sedation, tooth abnormalities, molar-incisor hypomineralization, dental anxiety, dentistry

## Introduction

Molar-incisor hypomineralization (MIH) is a qualitative enamel development defect that affects mainly the dental enamel of permanent molars and can also affect incisors. Currently, it has been accepted that even premolars and canines might present opacities that share MIH characteristics, lower mineral and higher organic content (1). Hypomineralized teeth are more porous and susceptible to wear by masticatory forces and demineralization processes, such as dental caries (2, 3). Although the etiology is not fully understood, genetic and environmental factors may be associated. In fact, MIH is a global concern in oral health and the prevalence of this condition can reach up to 44% (1, 3, 4).

Due to poor mineralization, MIH patients often require dental interventions, up to 10 times more than patients without the condition (2, 3). The accelerated evolution of dental caries and the difficulties in establishing satisfactory restorative procedures (that require satisfactory adhesion to the dental substrate), together with difficulties in the cooperation of children in the dental office, make the clinical management of MIH patients a challenge in the dental settings. Problems in child behavior can occur due to dental fear and anxiety during clinical procedures, especially related to dental pain (3, 5, 6).

Regarding pain, it is possible that the porosity of the enamel may provide the tooth hypersensitivity observed in MIH patients (5–7). Painful sensations can impair oral hygiene habits and increase the risk of dental caries, as well as difficulties in anesthetizing and controlling pain may occur in MIH patients, which can generate anxiety and behavior problems during clinical care (6).

Considering that the global prevalence of MIH is high, the increase in the number of diagnoses (especially in low/middle income countries) results in the need to promote oral health care, dealing with the challenges related to the management of hypomineralization defects and their consequences in each patient. Therefore, considering the frequent need for interventions, probable experiences with pain and discomfort must be taken into account, which leads us to concerns about behavioral problems in the dental office, as well as the strategies to manage them (4, 8). Recommendations for the use of nitrous oxide ($N_2O$) and oxygen ($O_2$) sedation in MIH patients were noted in Almulhim (2021) (9) and Jälevik and Klingberg (2002) (8). The first is a literature review, while the second was a case-control study where sedation was used but no further information on the sedation procedure was described.

Up to now, no study has systematically evaluated the use of sedation with $N_2O$ and $O_2$ in the behavioral management of MIH patients in the dental office. On the other hand, there is evidence for the safe and efficient use of this technique in dental settings. Sedation with $N_2O$ and $O_2$ may be useful to provide tolerability to dental treatment in fearful patients, helping to control anxiety and pain, as well as improving patient cooperation (8, 10, 11). Then, the objective of this study was to report a clinical case series using inhalation sedation with $N_2O$ and $O_2$ as a clinical strategy in the management of MIH in pediatric patients during dental treatment.

## Clinical cases

This clinical case series was approved by the Research Ethics Committee from the School of Dentistry of Ribeirão Preto - University of São Paulo (FORP/USP) under process number CAAE 52426521.4.0000.5419. The legal guardians and the participants were fully informed and formally signed the Informed Consent Term. Here, six clinical cases were selected. All procedures were performed at FORP/USP, under the supervision of professionals qualified for the inhalation sedation technique with nitrous oxide. Data collection took place in the clinical charts after the agreement of patients and their guardians. Teeth with MIH were classified according to the Ghanim index (12) by a trained and calibrated professional.

Prior to the procedures, a screening was performed to assess the applicability of the sedation technique in patients, such as clinical history, experiences with inhalation sedation, need to manage behavior in the dental office and the risk-benefit ratio. The Trieger psychomotor test and vital signs were duly evaluated in the pre- and immediate postoperative periods. For inhalation, an appropriate nasal mask for each patient was chosen to ensure an adequate sealing throughout the procedure (13). Considering that the patients were children, the oxygen flow was set at 4–5 L/min. The sedation level was established individually, by titration, while gas administration started and ended with $O_2$ (100%) for at least 3–5 min (14). Nitrous oxide release was gradually adjusted, often 10% per minute, until the needed sedation level was established for each patient, at most 70% $N_2O$ and 30% $O_2$ (15, 16), in order to achieve a level of moderate sedation, where the patient has a depressed state of consciousness but can respond to verbal commands with or without mild tactile stimulation (17).

### Case 1

A 10-year-old, female and black patient, who sought urgent care at the dental school. During the anamnesis, the patient reported odontophobia. In the oral clinical examination, it was observed that the patient had MIH and, after radiographic exams, needed restorative (units 14, 15, 42, 43, 45 and 46) and root canal (unit 36) treatments, as well as extraction of the unit 16. Due to persistent odontophobia, inhalation sedation with nitrous oxide and oxygen was chosen as the clinical strategy to perform the extraction of unit 16, which had B-5-III Ghanim index (12). In this case, 40% $N_2O$

and 60% $O_2$ sedation parameters were used, in addition to the greater palatine and posterior superior alveolar nerve blocks. The procedure was performed without complications related to the sedation technique. The patient was quiet, conscious and responsive, as well as showing less evidence of anxiety and involuntary movements (**Figure 1**). Vital signs remained stable throughout the sedation procedure.

## Case 2

A 11-year-old, female and white patient, was scheduled for dental restorations in units 11 and 26 (**Figures 2A,B**). During the anamnesis, the patient guardian reported her child presented intense fear of dental treatment and metallophobia. After clinical examination, the diagnosis of MIH was made. Units 11 (B-5-II Ghanim index) and 26 (B-5-III Ghanim index) (12) were restored with light-curing resin under absolute isolation (**Figures 2C,D**). In this case, 40% $N_2O$ and 60% $O_2$ sedation parameters were used, in addition to the infiltrative local anesthesia and greater palatine nerve block. The patient responded adequately to the sedation technique and was calm throughout the restorative procedure. There were no complications.

## Case 3

A 12-year-old, male and white patient, was attended for dental treatment. During the anamnesis, the patient was extremely phobic and reported feeling very afraid of dental anesthesia. Clinical examination revealed enamel defects in unit 11 (B-3-II Ghanim index) and all molars, confirming the diagnosis of MIH (**Figures 3A–C**). In this appointment, after radiographic examination (**Figure 3D**), the unit 16 (B-5-III Ghanim index) (12) was extracted using 60% $N_2O$ and 40% $O_2$ sedation parameters, in addition to the greater palatine and posterior superior alveolar nerve blocks (**Figures 3E–G**). Although the procedure was invasive, the patient was quiet and sedation helped to increase the patient's pain perception threshold. No complications were reported and the patient was released after the Trieger psychomotor test (**Figure 3H**).

## Case 4

A 8-year-old, female and white patient, after clinical examination was scheduled for dental restorations with light-curing composite resin in units 16, 26, 36 and 46


FIGURE 1
(**A**) Beginning of the procedure, with adaptation of the nasal mask, ensuring adequate sedation. (**B**) Extraction of tooth 16 with sectioned roots. (**C**) Patient signaling that everything is fine during care.

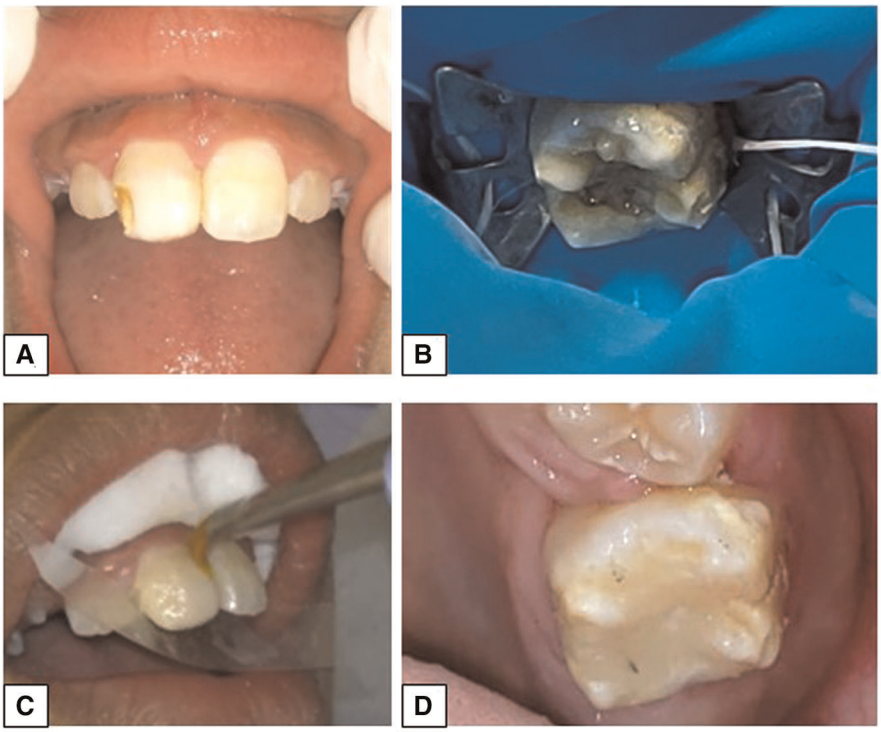


FIGURE 2
(A) Enamel defect and caries distal to element 11. (B) Rubber dam isolation with rubber dam on element 26. (C) Final image of the restoration after occlusal adjustment of the element 11. (D) Final image of the restoration after occlusal adjustment of the element 26.

using absolute isolation (Figure 4). In the first appointment, during the anamnesis, the patient reported feeling anxiety and fear in relation to dental treatment. Clinical examination revealed MIH and extensive destruction in unit 36 (B-5-II) and 46 (B-5-III) (12). In this case, to restore these units, 30% $N_2O$ and 70% $O_2$ sedation parameters were used, in addition to the inferior alveolar and lingual nerve blocks. The patient was cooperative and calm throughout the procedures, which were performed in one-week interval each. No complications were observed. At the last appointment, after 3 sessions using nitrous oxide and oxygen sedation, she agreed to undergo only local anesthesia, without sedation, and reported she was no longer afraid of dental treatment.

## Case 5

A 9-year-old, male and white patient, attended the dental clinic for root canal treatment. The clinical examination revealed the presence of MIH in incisors and molars (Figures 5A,B). Restorative treatment with light-curing composite resin was performed on the incisors and after radiographic examination, a pulpectomy was indicated for unit 36 (B-5-II Ghanim index) (12) (Figure 5C). During the procedure, the patient reported that he was in moderate pain during dental pulp extirpation and it was concluded that adequate anesthesia was difficult to obtain and patient became very anxious. Then, 40% $N_2O$ and 60% $O_2$ sedation parameters were used, in addition to the inferior alveolar and lingual nerve blocks which resulted in an improved local anesthesic efficacy. There were no complications and the patient remained quiet and did not report pain or discomfort during the procedure.

## Case 6

A 10-year-old female and white patient, was scheduled for dental restorations in units 16, 36 and 46. The diagnosis of MIH was made during clinical examination (Figure 6A). After consecutive failures, sedation was indicated to enable dental treatment on alternate days. For the units 16 (B-5-III Ghanim index), 36 (B-4-III Ghanim index) and 46 (B-4-III Ghanim index) 40% $N_2O$ and 60% $O_2$ sedation parameters were used, in addition to the greater palatine and posterior

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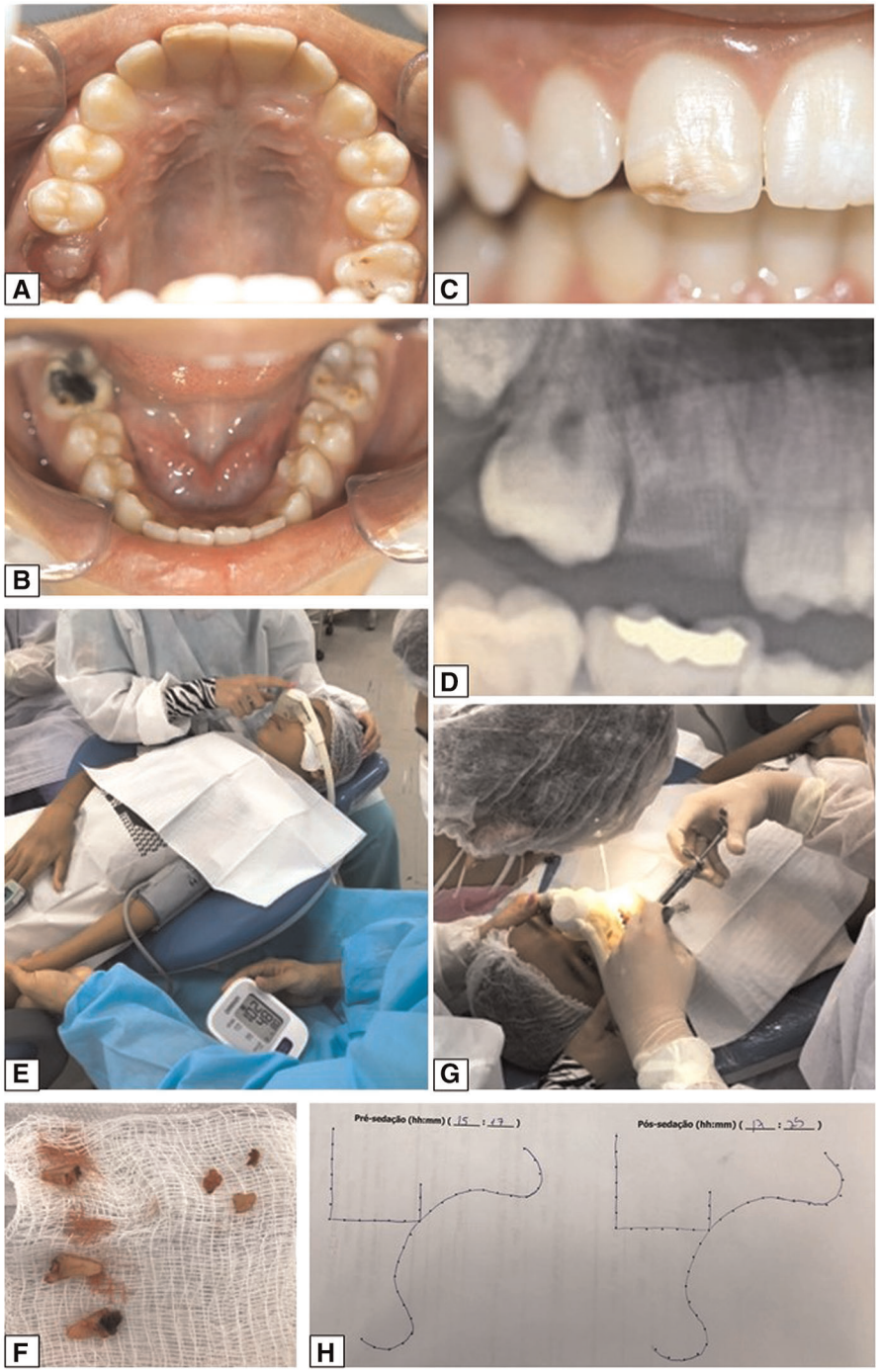


FIGURE 3
(A–C) Clinical images showing enamel defect on teeth 11, 26 and 36, extensive caries on teeth 46 and 16, confirmed by radiographic examination (D). (E) Patient calm during sedation and assessment of vital signs throughout the procedure. (F) Intraoral anesthesia for greater palatine and posterior superior alveolar nerve blocks. (G) Element 16 after extraction that required odontosection. (H) Trieger test performed before and after surgery.

superior alveolar nerve blocks. With the sedation technique, it was possible to carry out the necessary restorative treatments using light-curing composite resin under absolute isolation (Figure 6B). The patient was cooperative and calm during the procedures. Vital signs remained stable throughout the sedation procedure without complication.

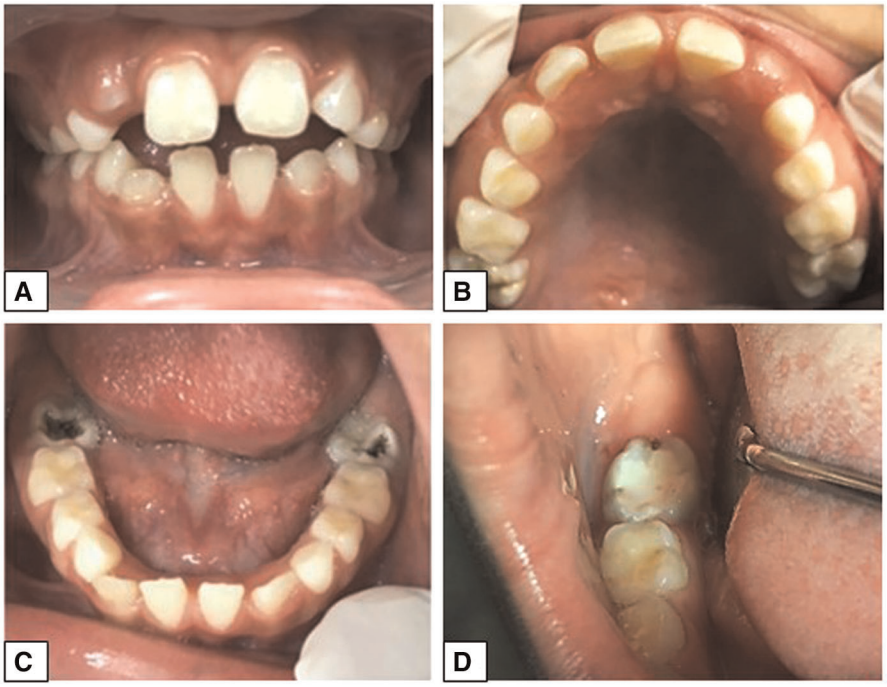


FIGURE 4
(A–C) Intraoral photographs of the patient. It is observed that the upper incisors have white-creamy opacities, teeth 16 and 26 have yellow-brown opacities on the occlusal surface, and teeth 36 and 46 have caries destruction involving the cusp in tooth 46. (D) Final image of the tooth 46 after restorative procedure.

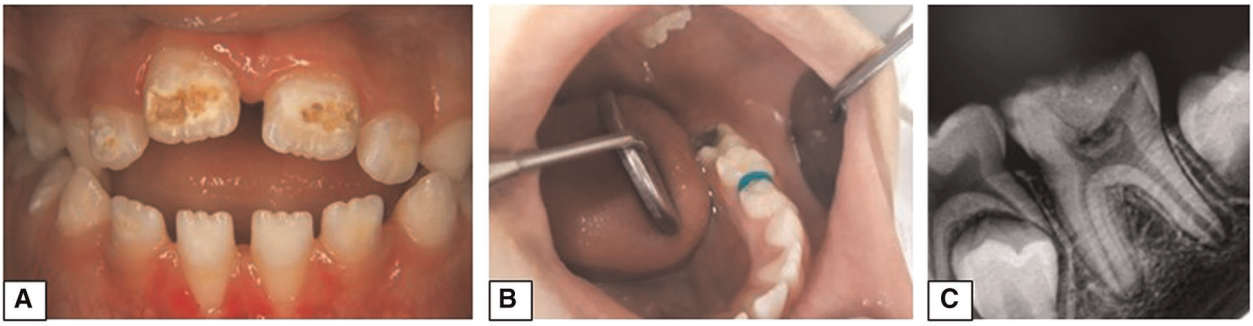


FIGURE 5
(A,B) Intra-oral clinical image of the patient. Demarcated opacities with post-eruptive breakdown are observed in the upper incisors and destruction by atypical caries in tooth 36. (C) Radiographic examination of element 36.

## Discussion

In this clinical case series, the use of inhalation sedation with $N_2O$ and $O_2$ was a strategy to enable the performance of dental procedures in MIH patients, mainly to deal with dental fear and anxiety. In pediatric patients, nitrous oxide sedation has been shown to be an effective, low-risk and safe alternative for the control of fear and anxiety in these patients (18), from the operating room to the dental office and emergency department, where its use alone or in combination with other agents can facilitate the performance of painful and/or anxiety-inducing procedures and is a viable alternative when the behavior is negative (17, 19, 20). Success in the use of sedation can be measured by the completion of the proposed/necessary treatment. A success rate higher than 90% of this approach in general practice has been reported, as well as more favorable

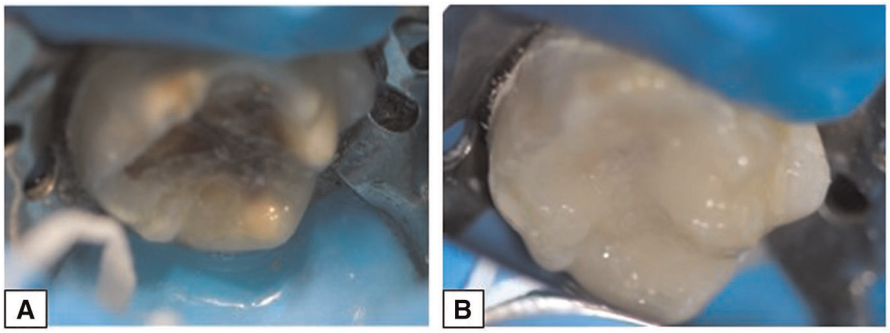


FIGURE 6
(A) Initial image of element 16 and (B) final image of the tooth after restoration with composite resin.

behaviors for the performance of dental procedures (21). Also, 88.9% of sessions using sedation had no adverse effects on patients and no serious adverse effects were observed in all sessions (21). The main adverse effects cited in the literature are over sedation, nausea, vomiting, sweating, dysphoria, restlessness, panics, respiratory depression, interactions with other medications and headache (21, 22) Clinical investigations are still needed to expand the level of evidence and the grade of recommendation on the effect of sedation in managing the behavior of MIH patients. Current evidence available does not specify these patients (22, 23).

Also, dentists need to deal with hypersensitivity in dental settings with MIH patients, including dental fear and anxiety associated. In fact, fear and anxiety regarding dental treatment is a common problem in different age groups and patient profiles. Hypomineralized defects are associated with increased hypersensitivity in patients with MIH, especially in molars with moderate or severe defects. Post-eruptive enamel breakdown can also exacerbate hypersensitivity (6, 24–26).

Reviews have already synthesized the evidence on the management of MIH, emphasizing the importance of pain and discomfort control, as well as discussing how hypersensitivity can hinder the action of anesthetic agents. There is extensive discussion of preventive agents, adhesion and restorative strategies, but behavior management, including the use of inhalation sedation with $N_2O$ and $O_2$, is not properly discussed. It is essential for professionals to be able to recognize that controlling pain is not the same as controlling fear and anxiety in dental settings (24, 27, 28). The guidance for clinical practice in MIH by the European Academy of Paediatric Dentistry (EAPD) recognizes the interface between MIH and behavior management, but sedation as a clinical strategy was not further discussed for these patients (29).

Sedation with nitrous oxide is a low-risk practice that allows the patient to control anxiety and is a common practice in several offices around the world. However, it is still not well described in the literature for patients with MIH. Still, we consider it to be a valuable clinical strategy to improve patient cooperation and address clinical problems related to MIH, mainly related to pain and anxiety. A systematic approach, by means of a randomized clinical trial, should be undertaken to investigate the efficacy of the use of inhalation sedation with $N_2O$ and $O_2$ in managing the behavior of MIH patients from different perspectives: tolerability to treatment, pain, fear and anxiety. Therefore, our clinical case series acts as a starting point, demonstrating the applicability of this technique in managing the behavior of children with MIH, including indications, parameters and associated outcomes.

## Patient perspective

In general, we observed that all patients were cooperative and remained calm during the clinical procedures. No complications, pain or discomfort were reported and all procedures could be fully performed.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee from the School of Dentistry of Ribeirão Preto - University of São Paulo (FORP/USP) under process number CAAE 52426521.4.0000.5419.

Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

## Author contributions

FWGPS, FKC and AMQ designed the case series protocol. FWGPS, KFM, RBC, MFMA and TCSF performed data collection from clinical records, as well as obtained the consent of patients and their legal guardians. The authors contributed equally in data analysis and manuscript writing and review. All authors contributed to the article and approved the submitted version.

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## Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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