Minimum intervention oral care management of early childhood caries: a 17-year follow-up case report

D. S. Wambier, A. C. R. Chibinski,
L. M. Wambier, M. F. de Lima Navarro[1], A. Banerjee[2]

Department of Dentistry, Ponta Grossa State University, Ponta Grossa, Paraná, Brazil
[1]Department of Restorative Dentistry, Bauru School of Dentistry, University of São Paulo, Bauru, Brazil
[2]Center of Oral Clinical Translational Sciences, Faculty of Dentistry, Oral & Craniofacial Sciences, King's College London, London, UK

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e-mail: anachibinski@hotmail.com

Abstract

Background Early childhood caries (ECC) has a profound impact on a child's quality of life, and its management remains a challenge for the paediatric dentist, mainly because it depends on radical changes in the child/carers' daily behaviour and any dental treatment must be provided to very young child.

Case report This case report describes the on-going care of a 2-year-old child presenting with ECC and management until permanent dentition is complete. All patient-focused, team-delivered care was delivered using the minimum intervention oral care framework, implementing non-invasive and minimally invasive preventive procedures. Throughout the care provided, oral and dental health education was reinforced in all visits. The child's mother was trained to perform effective biofilm control and dietary habits were adjusted, especially baby-bottle removal during sleep. The child was initially anxious and resistant towards any dental examination and clinical procedures. However, with effort from the oral healthcare team members, the patient became compliant, allowing the mother to perform suitable oral hygiene measures, as well as accepting the clinical procedures carried out by the paediatric dentist. The clinical procedures consisted of atraumatic restorations and fluoride varnish applications. During the subsequent years after the baseline treatment, follow-up visits included continued dietary and oral hygiene instruction with positive behavior reinforcement, fluoride topical applications and tooth-restoration complex maintenance with glass-ionomer cement where needed. Currently, the patient is 19 years old and has a stable, healthy permanent dentition..

Conclusion Understanding of the causes of oral diseases by the patients' caregivers, alongside with pragmatic practical guidance to maintain good oral health, can reduce the risk for acquiring future disease, since caries activity control is the basis for successful caries management.

KEYWORDS Children; Dental caries; Case management.

Introduction

The presence of one or more decayed, missing, or restored (filled) teeth in the primary dentition of children under the age of 6 is named Early Childhood Caries (ECC) and the treatment of severe ECC (S-ECC) has always been a challenge for paediatric dentists in both private clinics and public service, usually with limited resources. S-ECC exhibits a specific pattern of caries disease, with an acute development of lesions, particularly on the smooth surfaces of upper anterior teeth [Machiulskiene et al., 2020], while lower incisors can be completely healthy or only mildly affected.

The aetiology of ECC is multifactorial and complex involving environmental, behavioural, socioeconomic and biological factors. However, the main risk/susceptibility factors for this disease are lack of parental education and access to dental care, associated with unhealthy diet and poor oral hygiene [Anil and Anand, 2017]. Studies have shown that frequent dietary carbohydrate intake along with an undisturbed dental biofilm, can lead to dysbiosis of the microbial community resulting in an overproduction of acid with a positive selection towards acidogenic and acid-tolerant bacteria [Tanner et al., 2018]. This explains why improved efforts are required to restrict free sugars in the diet [Devenish et al., 2020].

ECC is a disease that may cause significant pain and discomfort, adversely affecting the child's quality of life [Alazmah, 2017; Colombo et al., 2019]. Furthermore, it must be considered the possible negative impact on the permanent dentition, that will emerge in the oral cavity under high risk for the development of caries lesions and/or developmental enamel defects [Grund et al., 2015; Phantumvanit et al., 2018]. There is a considerable financial cost and social implications when a child requires general anaesthesia for dental treatment [Phantumvanit et al., 2018]. Controlling the initiation and progression of the caries process in young children is essential to preserve good nutrition, speech development and formation of a positive self-image [Alazmah, 2017].

A systematic review estimated the global prevalence of ECC in different continents and showed the following percentages: Africa 30%; Americas 48%; Asia 52%; Europe 43% and Oceania 82% [Uribe et al., 2021]. Therefore, ECC remains highly prevalent in most countries around the world [Chen et al., 2018]. The World Health Organisation's Global Burden of Disease stated that 532 million children had untreated dental caries in deciduous teeth [Bernabé and Marcenes, 2020] and even in economically developed countries such as the United Kingdom, France, Germany and the United States, the treatment of decayed primary teeth is a public health challenge [Grund et al., 2015; Folayan and Olatubosun, 2018]. In Italy, the prevalence of ECC exceeds 35% [Severino

et al., 2021]. Latin American and Caribbean countries are equally impacted by the burden of dental caries due severe social inequalities [Sampaio et al., 2021]. The access to oral and dental care remains low in deprived communities in many countries around the world [Bernabé and Marcenes, 2020], with traditional dental operative treatments being expensive and the capacity of the public healthcare system often restricted to emergency treatment and pain relief [Duangthip et al., 2017; Chen et al., 2018]. Consequently, primary teeth often remain untreated [Chen et al., 2018]. Therefore, caries management by means of less invasive and more structured, prevention-based, cost-effective approaches, including Atraumatic Restorative Technique (ART), is a realistic and pragmatic alternative to the traditional surgical approach to treating cavitated teeth in young children [Chen et al., 2018].

To provide a clinical guide when treating such patients, a patient-focused and team-delivered strategy was developed. It is named Minimum Intervention Oral Care (MIOC) [Banerjee 2017, 2013, 2020; Heidari et al., 2020] and it comprises four interlinked clinical domains. The first one is the "identify domain", that includes suitable anamnesis, detection of early caries lesions and the identification of risk/susceptibility factors. The second one is the "prevent lesions/control disease domain", which encompasses tailored, patient-focused primary preventive non-invasive strategies, such as optimised diet, biofilm control, the use of fluoride/other remineralising agents, as well as the secondary preventive micro-invasive measures of sealants and resin infiltration techniques where appropriate. In this domain, the oral healthcare team plays the role of educator and health promoter, instigating long term behaviour changes and adherence in patients and carers. The third is the "MI restore domain" and it highlights the minimally invasive operative interventions for tertiary disease prevention, including ART. The fourth domain of MIOC framework represents "recall/review/re-assessment" and aims to maintain the patient's long term oral health by establishing follow-up visits according to his/her carers' specific needs. Such an approach has already been approved by experts as effective in the management of carious lesions [Frencken, 2017; Dorri et al., 2017; Martignon et al., 2019; Splieth et al., 2020; Alkhalaf et al., 2020]. Health professionals who care for children must know how to recognise and modify risk/susceptibility factors for the development of diseases, since events that occur in childhood can impact adult life.

This manuscript exemplifies the long-term case management of a 2-year-old child with ECC who received care using the aforementioned minimum intervention oral care (MIOC) framework with non-invasive, micro-invasive and minimally invasive primary, secondary and tertiary preventive procedures, over a seventeen-year follow-up period, maintaining oral and dental health into complete adult dentition.

Case report

This section follows the MIOC clinical structure outlined above.

MIOC Domain 1. Identifying the problem

A female infant with multiple carious lesions, aged 1 year and 9 months, presented for the first time at the dental clinic of the State University of Ponta Grossa - UEPG, in the city of Ponta Grossa (PR/Brazil).

The child's mother was concerned about the rapid decay of her daughter's teeth and came asking for help. During anamnesis collection, no systemic problems or allergies to food or medication were reported. The child was in good general health. She used to fall asleep at night with a bottle with milk and chocolate and consume other cariogenic foodstuff during the day in free demand, such as soft drinks, orange juice and cookies, all foods rich in sugar. In addition, she offered resistance to brush her teeth. According to data obtained in the anamnesis, the cariogenic diet and poor oral hygiene habits were responsible for dental caries. No other problems were detected, in addition to high caries activity and risk of new lesions. A typical case of severe ECC was diagnosed, usually beginning in the maxillary incisors, followed by maxillary and mandibular molars and affecting all teeth sequentially as they erupt [Machiulskiene et al., 2020].

During clinical examination, active carious lesions were observed in all upper and lower teeth, except for lower incisors and canines. Clinical findings included incipient enamel white spot lesions on teeth No. 51, 52, 61 and 85; cavitated lesions on teeth No. 53, 62, 63, 74, 75 and 84. Teeth No. 54 and 64 had atypical cavities; there were deep carious lesions in teeth No. 54, 64, 74, 84 and 75 and the upper second primary molars were erupting (Fig. 1 A-C). The child exhibited uncooperative behaviour, being very anxious as it was her first time at the dental clinic (Fig. 1 D-E).

MIOC Domain 2. Controlling the disease

2.1 Primary prevention

Given the characteristics of the disease, a critical initial step before starting any operative intervention was to explain to the mother, in lay terms, the reason for the development of these lesions. It was necessary to emphasise that the success of treatment depended on her collaboration, to control the causative factors of the disease: the high frequency of sugar intake, the use of feeding bottle during sleep and the inadequate oral hygiene. COM-B behavioural modelling techniques (Capability, Opportunity, Motivation and Behaviour) for the adoption of healthy habits [Newton and Asimakopoulou, 2017] was employed, since enhancing patients' oral health related behaviour is a critical component of the preventive approach which is central to the practice of minimally invasive dentistry.

The oral healthcare team included three paediatric dentists and dental students which commenced a two-way pragmatic facilitation and enablement process of the patient and carer, using capability, opportunities and motivational behaviour modelling (COM-B) to facilitate their combined behaviour change [Newton and Asimakopoulou, 2017]. It is fundamental to understand that parents of children with ECC face numerous barriers and that there are inherent difficulties to changing habits. All efforts were driven to the gradual exchange of the contents of the night bottle for water and to reduce the sugar intake during day time. It was emphasised that this process would not be simple and that there would be crying and resistance from the child. However, depending on their will and persistence, all the effort would be rewarded, preventing primary tooth loss and promoting a healthy environment for the permanent dentition [Newton and Asimakopoulou, 2017].

During the initial visits it was demonstrated how to perform adequate biofilm control at home (Fig. 2 A-B). Information to facilitate the process were provided, such as in the most suitable type of toothbrush and toothpaste [Suprabha et al., 2021] and the best position to support the child's head for effective and safe toothbrushing. The dental professionals

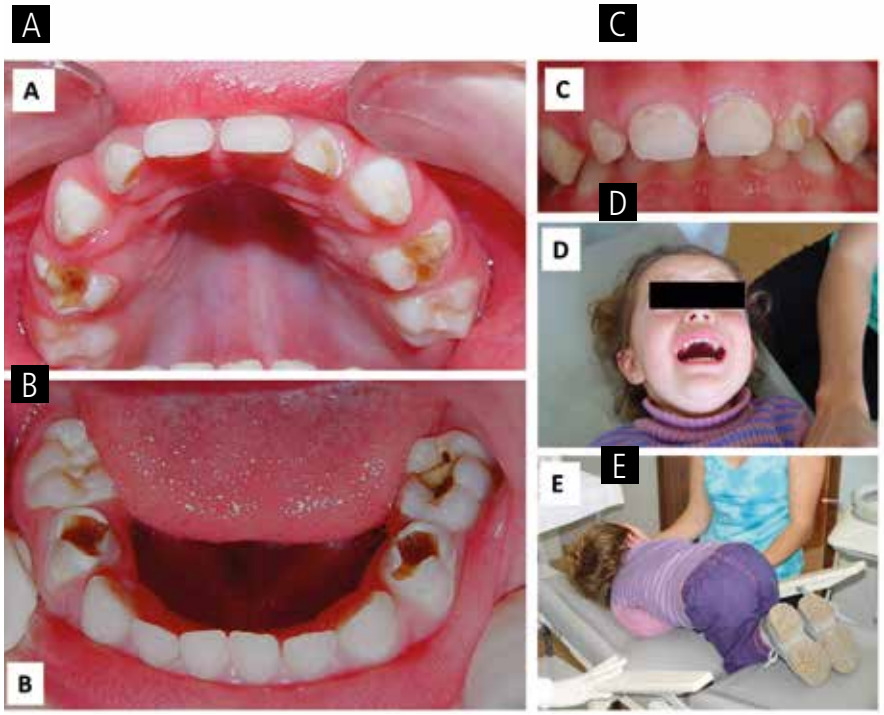


FIG. 1 Appearance of the dental arches (A-B) showing several active carious lesions in the posterior (A- B) and anterior teeth (C). Negative behaviour of the child at first clinical exam in 2003 (D-E).

FIG. 2 Several sessions of tooth brushing orientation were made with the mother and child (A-B) to capacitate the mother to perform adequate oral hygiene at home. Topical applications of fluoride varnish were also done to promote tooth remineralisation weekly (C).

worked with the mother as a team, always encouraging and offering her opportunities to clarify doubts. Regular toothbrushing with fluoride toothpaste is a fundamental primary preventive intervention for caries control [Yu et al., 2020]. Brushing with a small amount (grain of rice) of fluoride toothpaste (1000 ppm F) twice a day [Cury and Tenuta, 2014] and especially at night before the child fell asleep, was advised. A new soft toothbrush was provided for the child and the mother was asked to bring it to all appointments; a new toothbrush was provided when needed.

In the family's food routine, it was recommended daily intake of water instead of soft drinks and in the interval between the main meals, foods such as fruits and natural juices should replace those with cariogenic potential or with high sugar content. The mother was guided to check the content of each product before buying it. All these guidelines were reinforced during treatment and follow-up visits.

With these measures, a partnership with the mother was established, aiming to restore the homeostasis of the oral environment.

2.2 Secondary prevention

In addition to biofilm control and dietary advice (primary prevention), the sessions for remineralisation of initial lesions with topical fluoride are fundamental. It is worth mentioning that fluoride has also the potential to act in the prevention of new lesions development. Thus, professional application of 5% sodium fluoride varnish was used to treat white spot lesions, and even initial enamel cavitated lesions (fluoride therapy) (Fig. 2C). Consequently, at the beginning of the treatment to control the high caries activity, 5% fluoride varnish (Duraphat ®Colgate Palmolive) was applied once a week for 4 weeks.

The application protocol is very simple: after removing the biofilm with a toothbrush, teeth are isolated by hemi-arch with cotton rolls, dried and the fluoride is applied on the dental surfaces. The number of sessions needed may vary from patient to patient; the remineralisation response of the enamel initial lesions will determine it.

MIOC domain 3. Minimally invasive operative tertiary prevention

The International Caries Detection and Assessment System (ICDAS) allows the detection of dental caries clinically as well as its depth with a substantial level of accuracy [Ekstrand et al., 2018]. The severity ranges from the early clinically visible changes in enamel caused by demineralisation to extensive cavitation. ICDAS scores (0 to 6) were recorded to carry out the personalised treatment plan and subsequent monitoring

of the carious lesions. As shown in the sequence of images at baseline (Fig. 1 A-C), the following scenario was observed: non-cavitated lesions score 2 (No. 52V, No. 61V, No. 85O), enamel cavitated lesions score 3 (No. 51V, No. 53P, No. 63P) and dentin cavitated lesions score 6 (No. 62V, No. 54O, No. 64O, No. 74O, No. 84O, No. 75O). Non-invasive strategies were employed for scores 2 and 3 (MIOC domain 2) and the wide and atypical cavitated lesions (score 6) were managed by Atraumatic Restorative Technique (ART) to preserve the pulpal vitality and to save tooth tissue (MIOC domain 3).

The need for complex restorations at the beginning of the restorative treatment was expected and this was accomplished in a very young patient with very negative behaviour. The use of sedation or general anaesthesia was not considered since the child was treated in an university dental clinic. She

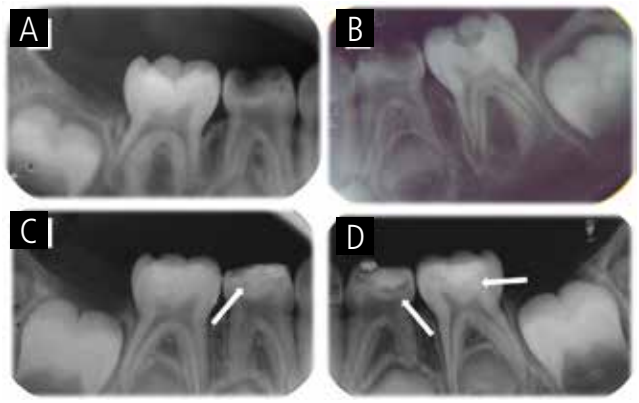


FIG. 3 Radiographs of deciduous molars before (A-B) and 16 months after ART restorations (C-D). The presence of a more mineralized dentin tissue can be seen under the restorations; no signs of pathological pulp conditions are present. The development of permanent teeth is occurring as expected.

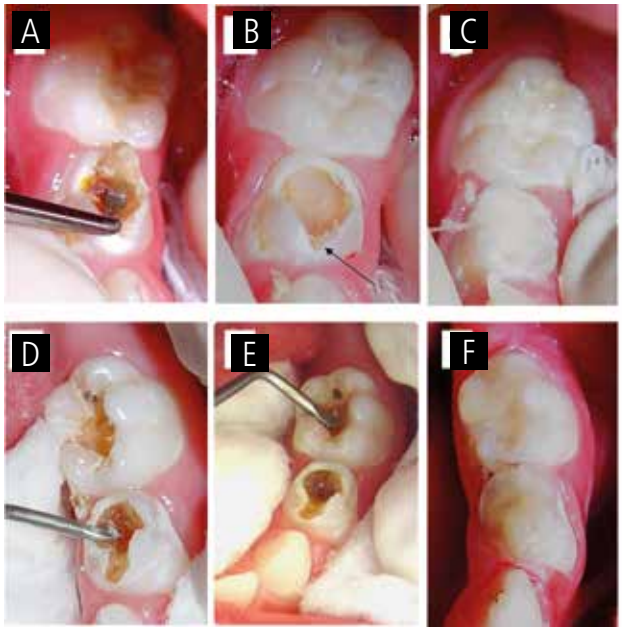


FIG. 4 Deep carious lesions were seen in teeth No. 74, 75 and 84 (ICDAS 6). Restorative procedures consisted in selective removal of carious dentin to soft dentin and restoration with GIC. Tooth No. 85 (ICDAS 2) was treated with GIC sealant (C). There was a failure in the cavity preparation of teeth No. 84 and residual carious tissue can be seen at the cavosurface margin (black arrow) (B).

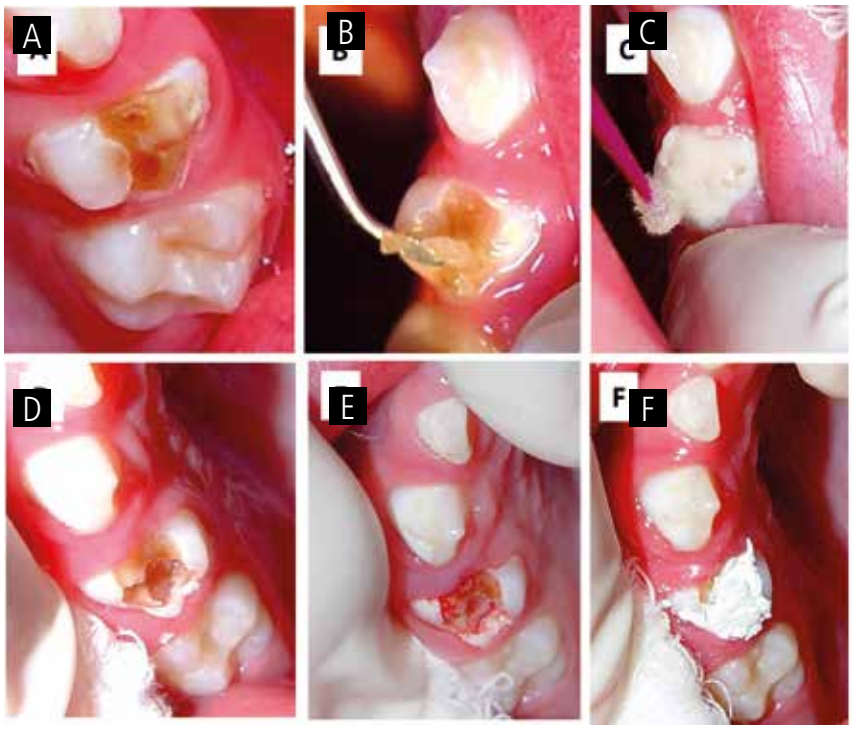


FIG. 5 Teeth No. 64 (A) and 54 (D) exhibited atypical caries lesions. ART restoration was done on tooth No. 64 (C). On tooth No. 54 (D), gingival bleeding occurred during selective caries removal (E) and the cavity was provisionally sealed (F).

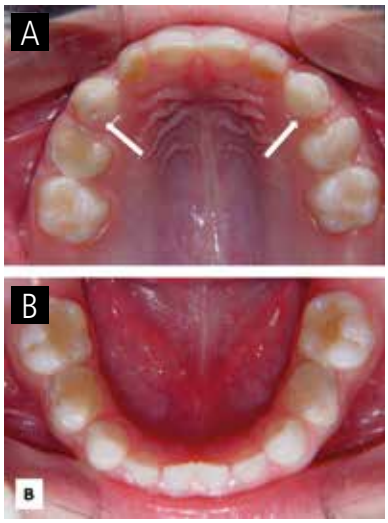


FIG. 6 Clinical aspect of upper (A) and lower (B) dental arches two years after the beginning of the treatment. The change in negative environmental factors (diet/hygiene) determined the control of the disease. The enamel lesions (ICDAS 3) on the palatal surface of the upper canines (white arrows) were inactivated without the need of restorative procedures (A). ART restorations/sealants exhibited good clinical conditions.

offered a great resistance, which made operative interventions difficult. Even so, the treatment was carried out in the shortest possible time, aiming to reduce the child/mother stress, and, at the same time, to seal the cavities in order to stop carious lesions development. The treatment of the deciduous molars was prioritised. The upper molars were treated in one session (Fig. 5 A-F), and the lower ones in another (Fig. 4 A-F). There was a non-cavitated active lesion in the occlusal surface of tooth No. 85 that was sealed (secondary prevention) (Fig. 4 C).

Radiographic examination confirmed the presence of deep carious lesions (teeth No. 74, 75 and 84), yet without the presence of pain or signs of pulp pathology (Fig. 3 A-B). For these deep cavities (ICDAS 6), selective caries removal and sealing (ART restorations) was the best alternative to avoid the risk of pulp exposure and to eliminate dental sensitivity that could hinder toothbrushing (Fig. 4-A-F). The teeth were restored with resin-modified glass-ionomer cement (RMGIC-Vitremer, 3M-ESPE) after selective caries removal to soft dentin [Schwendicke et al., 2016] with hand instruments, without anesthesia or absolute isolation. This restorative material was selected to allow better control of the setting time.

Two exceptions were made to this protocol. One of them was tooth No. 62. Since the carious lesion involved the incisal edge of this tooth, it was decided to use an acetate matrix (TDV Dental) filled with composite resin (Z100TM 3M ESPE). The other one was tooth No. 54. When removing the carious dentin from tooth No. 54, gingival bleeding occurred (Fig. 5 E) and the tooth was restored temporarily using zinc oxide-eugenol cement (IRM Kit – Dentsply) (Fig. 5 F). On a consecutive session, tooth No. 54 (ICDAS 6) showed signs of degenerative pulp alterations and endodontic treatment was performed followed by composite resin restoration.

MIOC Domain 4. Tailored recall visits

Follow-up visits were scheduled with the objective of assessing the child's oral clinical condition and the compliance with behaviour readjustments; reinforcement of educational measures was also carried out alongside with further fluoride varnish applications. Commonly, it took about 15 minutes for professional brushing, clinical exam and fluoride therapy, and about 30 minutes to reinforce dietary guidelines and the importance of the biofilm control with the mother. At these visits, the mother was encouraged to talk freely about advances and difficulties in the process; alternatives to overcome the pitfalls were proposed. In addition to toothbrushing, flossing was also stimulated. Child's resistance and crying was common in the first month of dental care. This disruptive behaviour gradually changed and, during the follow-up appointments, the child became very cooperative. Dental recall interval protocols are planned to prevent a reactivation of caries disease through regular evaluations and preventive procedures [Martignon et al., 2019]. In this case, considering the high risk of developing dental caries, the following-up visits in the first year of treatment were scheduled weekly for the first month, then every 3 months and finally every 6 months. At the one-year follow-up, intraoral examination showed a satisfactory oral health, with low levels of biofilm. In each return appointment fluoride therapy was performed and brushing guidelines and dietary counseling were reinforced.

<2 to 3 years old (2003-2004)

During the first month follow-up, tooth No. 84 restoration showed a gap at the cavosurface margin. This probably happen because, during the first visits, the management of child's behaviour was very difficult, and some carious tissue was left at this site during cavity preparation (Fig. 4 B). Without removal of the remaining GIC, the margins were prepared with hand instruments and the ART restoration was repaired.

After 16 months of follow-up visits from the initial restorative treatment, the radiographic examination of lower primary molars (No. 74, 75 and 84) showed that carious lesion progression had stopped, demonstrating that indirect pulp therapy was successful (Fig 3A-D).

>4-6 years old (2005-2007)

Considering that the patient had achieved oral cavity homeostasis, now annual follow-up visits were scheduled, as stated in the MIOC Domain 4, which indicates tailored recall visits according to the patient's needs.

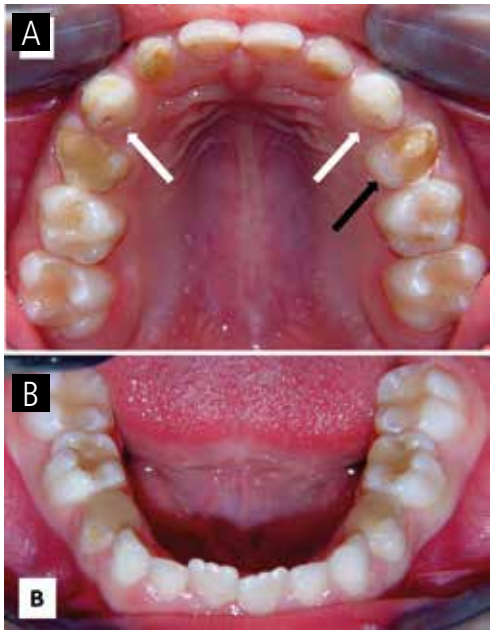
Clinical follow-up exam in 2005 showed that the treatment approach used contributed a huge change in environmental factors (diet/oral hygiene), that associated with the clinical procedures accomplished, determined the effective control of the disease and the child presented with all primary teeth stable in a healthy mouth (Fig. 6 A-B). This phase of care was successfully completed.

In 2006, the patient was in the mixed dentition phase (Fig. 8 A-B), with all first permanent molars present erupted as well as lower central incisors. The ART restorations in deciduous molars suffered wear and colour change over time, but it was considered a success since the disease was controlled and the teeth were kept in function in the oral cavity without more invasive/complex interventions.

The lack of progression of carious lesions (ICDAS 2) in the upper incisors was observed and the white spot lesions migrated away from the gingival margin with the continuing eruption of these teeth (Fig. 7), making the biofilm control easier and more manageable. It was also observed the inactivation of the cavitated enamel lesions on the palatal surfaces of the upper canines (ICDAS 3) (Fig. 8A) thanks to mechanical control of the biofilm and fluoride therapy. The first permanent molars were protected with resin pit and fissure sealant (Fluroshield®-Dentsply) (Fig. 8). There was total loss of the restoration of tooth No. 64, exposing a hard and remineralised dentine tissue; the shape of the cavity allowed the direct contact of fluoride dentifrice and toothbrush for good biofilm control, therefore the cavity was not restored (non-restorative caries treatment) (Fig. 9 A; Fig. 10 B).

In 2007, all permanent incisors were present (Fig. 9 A-B). Tooth No. 64, that had lost a restoration one year before, still showed a remineralised dentin surface (Fig. 8 A). Tooth 74 (Fig. 9 B) was restored using dental amalgam by another

FIG. 7 In 2006, inactive lesions could be seen on the upper deciduous teeth. The continuity of the eruption proccess showed a strip of sound enamel in the cervical portion of the dental crowns.



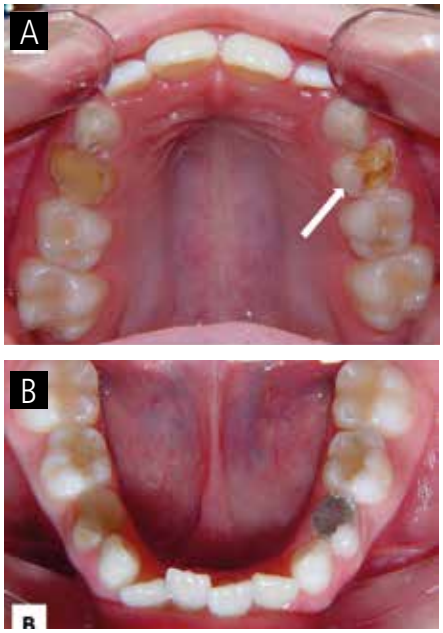


FIG. 8 Two years after the beginning of the treatment, tooth No. 64 lost the restoration (A), but it exhibited a remineralised and hard dentin surface (black arrow). Enamel cavitated lesions (ICDAS 3) remained inactive (white arrows). The patient was entering the mixed dentition period and the first permanent molars received pit and fissure sealants (A, B).

FIG. 9 Four years after the beginning of the treatment, all permanent incisors are present (A-B). Tooth No. 64 still showed a hard dentin surface (white arrow). Tooth No. 74 (B) was restored with amalgam by another dentist.

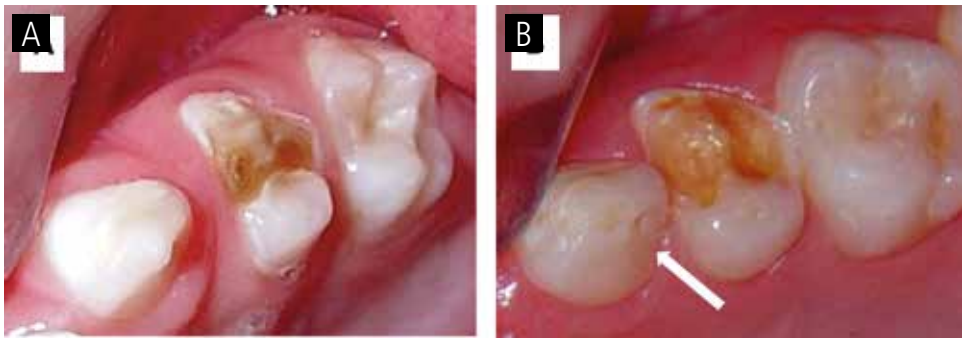


FIG. 10 A closer view of tooth No. 64 before (A) and 4 years after treatment (B). The softened and easily excavated dentin (A) became completely remineralised (B). Tooth No. 63 has controlled lesion on palatal surface.

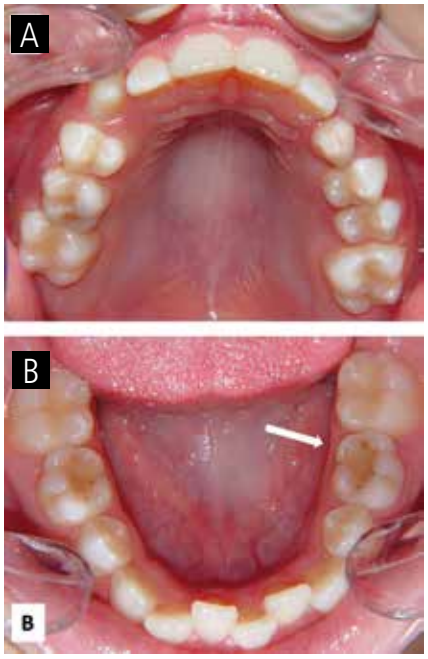


FIG. 11 In 2009, tooth No. 75, which was close to exfoliation (white arrow), was extracted and submitted to SEM analysis.

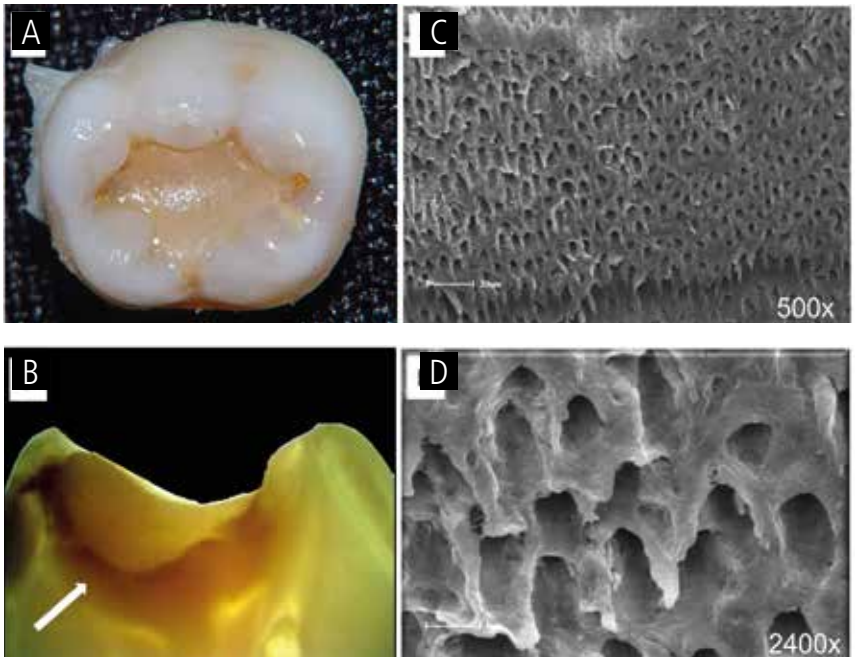


FIG. 12 Occlusal wear of the glass-ionomer cement without loss of tooth structure (enamel fracture) or recurrent caries lesion in tooth No. 75 (A). After sectioning, It is possible to see a wide layer of sclerotic dentin (B). The presence of good tissue organisation and dentinal tubules without bacterial contamination can be seen at X500 (C) and X2400 (D) magnification.

FIG. 13 After 7 years of follow-up, in 2010, it was possible to see a small incisal fracture of tooth No. 11 (A), all premolars were present (B-C), and tooth No. 37 was erupting (C).

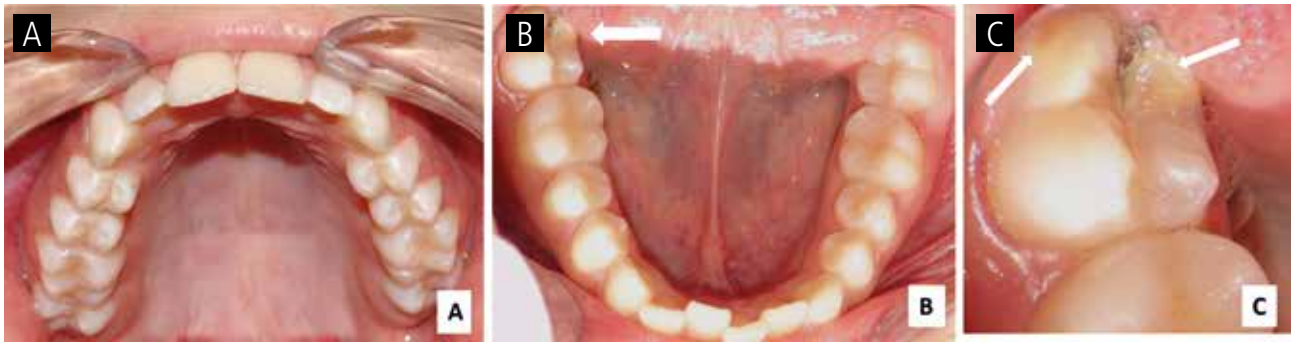


FIG. 14 In 2011, all permanent second molars are present; tooth No. 47 showed an enamel development defect (B).

FIG. 15 Tooth No. 47 was treated by means of ART technique; removal of carious dentin (B) and restoration with GIC (C).

dentist at the child's school, probably because its wear or fracture. Some elementary schools in Brazil have dentists to provide dental care to the students. It was hypothesised that the dentist did not know how to intervene in a minimally invasive way and was not used with GIC or ART, which led to the replacement of the restoration.

Defective restorations need to be repaired and not replaced when possible, allowing the dental structure to be preserved [Martins et al., 2018]. Therefore, after the restoration replacement, it was emphasised to the mother the importance to look for our dental team if she observed any flaws in the restorations as well as to return for the recall visits. This would allow monitoring and appropriate minimally invasive repair/management of the remaining tooth-restoration complexes, given that the best treatment for potentially defective tooth-restoration complexes is conservative management using the "5Rs" principle [Green et al., 2015; Martins et al., 2018], which call for Reviewing, Resealing, Refurbishing, Repairing and, if the other alternatives are not possible, Replacing failed restorations.

Figure 10 highlights the Minimally Invasive Dentistry principles put into action. After 4 years of follow-up (Fig. 10 B), as the result of a well-designed and conducted treatment protocol, it is possible to observe the clinical signs of the paralysation of the caries disease, in its different degrees of severity: non cavitated enamel lesions (buccal surface of tooth No. 63), cavitated enamel lesions (palatal surface of tooth No. 63) and cavitated dentin lesions (tooth No. 64).

>8-10 years old (2009-2011)

Despite some difficulties (the child's mother had started a new job and the patient was attending full time school), the follow-up visits were kept as planned. This allowed to continue the evaluation of the child's oral conditions and the compliance with hygiene and dietary instructions, as well as the accomplishment of any other clinical procedures needed.

In 2009 (Fig. 11 A-B), since tooth No. 75 exhibited great mobility and was close to exfoliation, it was extracted (Fig. 12 A), with the patient's and her mother's consent and it was evaluated under scanning electric microscope (SEM). Tooth No. 75 (Fig. 12 A) was stored and prepared for qualitative microscopic observation. It was sectioned in mesial-distal direction using a cutting machine (Isomet 1000, Buehler Ltd., Lake Bluff, Illinois, EUA) and a diamond disc (15 HC-4in, Buehler Ltd., Lake Bluff, Illinois, EUA) at 300 rpm under water refrigeration. The resulting tooth slices were polished for observation under optical microscopy and gold sputtered for SEM. Although the wear of the RMGIC restoration is clear (Fig. 12 A), it did not jeopardize the dentin-pulp complex capacity to produce tertiary dentin under the restoration and

FIG. 16 A-C In 2013 the patient was on orthodontic treatment; restoration of tooth No. 47 was adequate (B, white arrow).

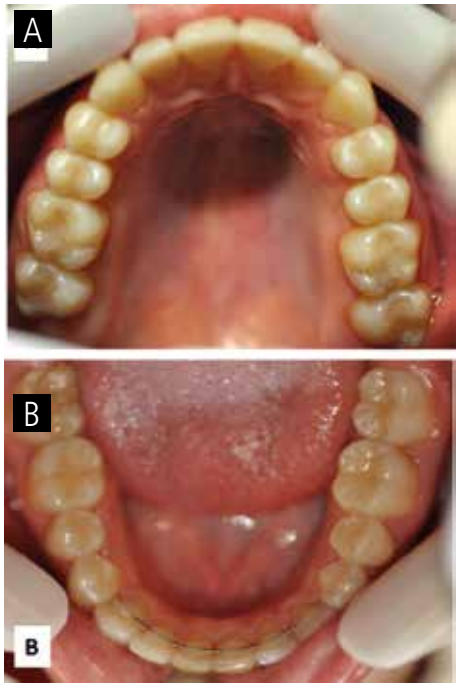


FIG. 17 In 2017, there was the presence of orthodontic retainer in the anterior lower teeth (B), without signs of caries activity.

FIG. 18 Photographic sequence of the patient face expressions after each dental visit, showing the potential of Minimum Intervention Dentistry as a tool for child behaviour management.

no carious dentin could be seen under optical microscopy (Fig. 12 B). The SEM analysis corroborated this finding. There was no sign of microorganisms or exposed collagen fibrils. The dentin under restoration showed good tissue organisation and remineralised structure with narrow diameter of the dentin tubules (Fig. 12 C-D).

In 2010, 7 years after initial treatment, the permanent dentition was almost complete. A small incisal fracture of tooth No. 11 (Fig 13 C) was detected, and this tooth was restored with a resin composite (Z100TM 3M ESPE). All premolars were present (Fig. 13 A-B) and tooth No. 37 was partially erupted (Fig 13 B). Teeth treated with ART restorations and selective caries removal exfoliated naturally and the natural cycle of deciduous teeth was fulfilled. The aim of the treatment was to keep deciduous teeth on the arch until their replacement by the permanent ones and to provide a healthy oral environment for the permanent dentition. This objective was fully achieved.

In 2011, all permanent second molars were present (Fig. 14 A-B). Unfortunately, tooth No. 47 erupted with an enamel defect known as hypomineralisation of other permanent teeth (HOPT) [Kevrekidou et al., 2021] (Fig. 14 B-C): yellowish demarcated opacities could be observed (Fig. 15 A) on the buccal and palatal surfaces of the tooth, which probably led to the post eruptive fracture of the enamel and the development of a carious lesion, which was restored using the ART technique (Fig. 15 B-C). The other three second permanent molars were sealed (Fluroshield®-Dentsply).

> 12-16 years old (2013-2017)

In 2013, the patient returned with a fixed bonded orthodontic appliance (Fig. 17 A-B). Tooth No. 47 restoration was adequate (Fig. 16 B) as well as the dental biofilm control. The patient remained under the care of the orthodontist.

In 2017 follow-up, the orthodontic treatment was finished (Fig. 17 A-B) and there was an orthodontic retainer placed on the lingual surface of the mandibular anterior sextant (Fig. 17 B). The homeostasis of the oral cavity was maintained, without any evidence of caries activity. Fortunately, we were able to examine a teenager enjoying a healthy permanent dentition (Fig. 16 A,B,C).

Finally, it is possible to observe on Figure 18 the evolution of the child behaviour as well as her attitude towards dental care. The negative behaviour that was present in the first dental visits in 2003, with extreme

demonstrations of fear and anxiety (Fig. 18 A), gradually was replaced by a cooperative behaviour, but yet with signs of shyness in 2005 (Fig. 18 B). Over the next few years (2006–2017), our dental team was able to witness the growth and development of a young teenager, who was aware of her participation at the obtention and manutention of a good oral health. This was possible due to control of biofilm/diet and family motivation, as well as the management of the caries disease through the MIOC framework.

Discussion

This paper reports the management of a patient with severe early childhood caries (S-ECC) using the Minimum Intervention Oral Care framework. During a period of 17 years , the patient was monitored and the active phase of the disease have never returned, allowing a health development of the permanent dentition. Although the clinical case reported here have been started in 2003, it is in accordance with the recent guidelines proposed by Caries Care International [Martignon et al., 2019], a clinical practice to control the dental caries through of 4D cycle (Determine/Detect/Decide/Do), involving an important partnership with patients to maintain their oral health.

The treatment protocol focused on the use of preventive measures, as well as non-invasive and minimally invasive operative procedures to manage existing lesions. All the procedures performed can be considered tooth- and patient-"friendly", since they save tooth structure and, at the same time, due to their atraumatic characteristic, without trigging the fear and anxiety that the so-called "conventional treatment" may induce [Heidari et al., 2020]. Also, our dental team gave to the patient and her family the necessary knowledge and the adequate tools to control the disease. The MIOC framework makes it clear that the association between family and dental professionals and individualised treatment plan and follow-up schedule are the fundamental for the success of the treatment and the maintenance of oral health over time. Although such prevention-based protocols and minimally invasive methods have great potential for the management of caries disease, they are still underused and many ECC cases have been left without adequate care/treatment [Duangthip et al., 2017]. It is common that, in very young and uncooperative children, ECC treatment becomes synonymous with sedation or general anesthesia. Both strategies are valid and may be indicated in certain situations, but these more invasive strategies for behaviour control require additional equipments and professionals in order to be done securely, and the treatment becomes much more expensive for public or private dental care. Therefore, a personalised plan with minimally invasive interventions is an alternative to provide the treatment needed in an effective way with and excellent cost-benefit. As dental appointments took place, the patient gradually overcame her fears, her mother was able to learn and deliver the appropriate at-home preventive care and the operator stablished a relationship of respect and confidence with the family. As for the operative phase of the treatment, clinical interventions were based on selective caries removal strategy and restoration with adhesive and bioactive dental material. The molars with deep lesions had their pulp vitality preserved and the caries-affected dentine left in the cavity act as a natural pulp protection layer, becoming remineralised over time.

During the first follow-up period, some restorations required repair. This was seen only at the beginning of the treatment, when the intervention needed to be quick and the patient was not cooperative. After this period, the ART restorations were always judged as acceptable, and the teeth remained in function until exfoliation.

It is important to point out that in some teeth, the shape and size of the cavities were not adequate for ART restorations, and we choose to perform them even so. An example of this situation is tooth No. 64, that lost the restoration months after its placement. Notwithstanding, the short period of time that the cavity remained sealed was enough to allow the carious dentin remineralisation. Therefore, in the sequence, the non-restorative caries treatment was performed in this tooth with success, which indicates that not always a failed restoration needs to be replaced.

The use of topical fluoride at home (dentifrice) and professionally applied (fluoride varnish) is fundamental to remineralise the lesions and to enhance the tooth ability to face further demineralization processes. The recall visits (MIOC domain 4) were employed as an opportunity to encourage daily oral hygiene with fluoride toothpaste and to perform further fluoride applications, ensuring that fluoride was always present in adequate concentrations at the oral environment.

Undoubtedly, optimal biofilm control and reduced consumption of sugar remains the paramount for successful caries control in young children [Duangthip et al., 2017]. It is important to inform the family regarding daily sugar-consumption recommendations, as well as the sugar content of foods, beverages, and oral liquid medications.

For permanent molars and premolars, the primary approach to prevent occlusal carious lesions should be brushing with fluoride toothpaste [Splieth et al., 2020]. However, due to the patient's caries susceptibility at the time of their eruption, pit and fissure sealants may be applied on the occlusal surfaces of these teeth.

The presence of hypomineralisation in one of the second permanent molars (tooth No. 47) was an unexpected and disappointing event. There is no significant relationship between ECC and developmental enamel defects [Míšová et al., 2021]. The rough and porous area of developmental defects fractured even before the finishing of the eruption process. It favoured the retention of biofilm, and consequently, the development of dental caries. All these factors are commonly associated with hypomineralised teeth [Fatturi et al., 2019; Bandeira Lopes et al., 2021] and the best approach to treat such a tooth is to adopt a minimally invasive restorative procedure with bioactive material.

All of the key domains of minimum intervention oral healthcare were included in the management of this patient over the 17 year period. These included caries detection and diagnosis, prevention and control of oral disease, minimally invasive (MI) operative interventions and periodic review visits [Banerjee, 2020]. A philosophy of effective patient-focused disease prevention and tooth preservation is essential. In this case report, the success achieved and the possibility of monitoring during the entire period of primary dentition until the completion of permanent dentition was the result of the partnership established with the child's mother who adhered to the treatment proposal since the first interventions. A frank dialogue explaining the causative factors and behaviours of caries, accompanied with constant guidance and motivation using COM-B behavioural modelling techniques [Newton and Asimakopoulou, 2017] for the adoption of healthy habits,

was key to the success of the treatment. The patients' carers understanding of the causes of oral diseases, alongside with pragmatic practical guidance to maintain good oral health, can reduce the risk for acquiring future disease [Heidari et al., 2020], since caries activity control is the basis for successful caries management. Many parents, nowadays, look for instructions online, but the quality of the information available on websites is of poor quality and do not replace professional counseling [Ayala Aguirre et al., 2022]. These facts were confirmed in this case report, and it was possible to prove that even in challenging situations such as severe ECC, MIOC and minimally invasive dentistry (MID) are effective in controlling behaviour and promoting long term oral and dental health.

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