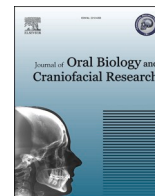




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Early diagnosis of early childhood caries: A simple novel tool (MAAC charts) for parents and caretakers

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ABSTRACT

Early Childhood Caries (ECC) is a condition associated with nearly 123 risk factors. Among all the risk factors, enamel defects or enamel hypoplasia (ED/EH) has been shown to be the primary risk factor. ED/EH comprises the earliest changes that manifest on newly erupted primary tooth surfaces soon after its eruption. ED/EH appears as white lines or patches, either as demarcated or diffuse opacities on the enamel surface. It is often observed on the labial and buccal surfaces of the newly erupted primary maxillary incisors. A simple self-report tool for mothers/caretakers, healthcare professionals, and primary care workers to diagnose early changes in ECC may facilitate early diagnosis. The MAAC chart was developed to prevent ECC in children with cleft lip and palate. These charts, primarily developed to educate parents, caregivers, healthcare professionals, and primary health care providers, illustrate the variations in ED/EH on the enamel surface (demarcated and diffuse opacities on various maxillary teeth) as a collage of pictures organized as incisors and canines. This paper describes a novel and simple, tool called 'MAAC charts' providing guidance on early signs of Early childhood caries (ECC) for health professionals, parents and caretakers. MAAC charts can be useful for Pediatric dentists while providing anticipatory guidance during early first dental visits in their office. Pediatric dentists can suggest paediatricians to use these MAAC charts, in vaccinations clinics and various in/out patient settings to provide oral health related anticipatory guidance. Pediatric dentists can use these MAAC charts in large scale public health campaigns focused on preventing ECC.

1. Introduction

Oral diseases affect 3.5 billion individuals.¹ Despite significant progress in dentistry, oral health has been neglected largely by the global health community, with nearly 530 million children suffering from untreated dental caries. Early childhood caries (ECC) presents a major global health burden.² ECC is associated with local pain, infection, abscesses, and disturbed sleep pattern. It can also affect children's emotional status and decrease their ability to learn and perform their usual activities.²⁻⁴ The risk of cavities in permanent dentition increases four-fold in children affected with ECC.^{2,5} Studies have shown that ECC is associated with approximately 123 risk factors. Compelling evidence exists that enamel hypoplasia (EH) (OR = 14.62) is the primary risk factor.^{5,6}

The enamel of primary teeth develops from approximately the 13th week of gestation to three years of age. Systemic influences ranging from pregnancy conditions (preeclampsia) to neonatal disruptions (preterm

births) and postnatal infections (rubella and chickenpox) can cause abnormalities in enamel formation resulting in EH.^{7,8} The prevalence of EH in primary dentition has been reported to range from 25 % (general population in the USA, India, Brazil, and Australia) to over 70 % (pre-term children and indigenous populations) worldwide.^{5,8,9} The high prevalence of EH reflects the vulnerability of developing teeth to environmental changes during gestation and early childhood.^{5,9}

The World Health Organization (WHO) Implementation Manual 'Ending Childhood Dental Caries' was developed and published in 2019 to serve various stakeholders. In this manual, the authors highlighted the significance of early diagnosis in ending ECC and the need to integrate oral care into mainstream healthcare delivery methods (overall health initiatives).² Watt also emphasized that rather than being isolated and separated from the mainstream healthcare system, dentistry needs to be integrated, particularly with primary care services, and the current global drive on Universal Health Coverage (UHC) provides the best opportunity for this integration.¹⁰

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Early diagnosis is pivotal for ECC prevention as caries progress rapidly in the primary dentition. Early intervention can prevent or reverse the associated problems.⁴ It has been postulated that cavities are nearly 98 % preventable if examined immediately after the first tooth eruption.¹¹ Systematic review on ECC prevention and management have highlighted early introduction and sustained interventions as the best care methods for preventing the disease.^{5,6} Evidence has revealed that visits to pediatricians compared to dentists are numbered 250 to 1 at age three.¹² Similarly, for children with cleft lip and/or palate, a medical home is established within days or months of birth.^{11,13} Because the youngest pediatric patient population visits the pediatrician/cleft unit more frequently than the dentist, it is imperative that pediatricians, healthcare providers, multi-disciplinary cleft teams, non-dental healthcare professionals, and parents/caregivers (all the stakeholders involved in the child's well-being) be trained in or have simple tools for early diagnosis of the earliest changes on the enamel surface manifesting as EH/ED soon after the eruption of the tooth.

Thus, a paradigm shift is needed to achieve easy and “sustainable goals” to promote the early identification and diagnosis of EH/ED by all stakeholders. A tool that can be integrated into the mainstream and overall health initiatives would be beneficial. Hence, we introduce a simple diagnostic tool called the MAAC chart for all stakeholders as a self-reporting or early diagnostic tool to identify the earliest changes on the enamel surface.

2. The rationale for the MAAC chart

Despite efforts made by the dental fraternity to promote “first dental visit” by one year of age or after the first tooth eruption, parents still fail to take their children to dentists across the globe. The average age of the children during their first dental visit is three years.¹⁴ Statistics reveal that more than 30 percent of children are affected by ECC by three years of age.¹⁵ This negligence may be due to lack of knowledge and awareness regarding ECC and its consequences. Therefore, there are two rationales for developing a MAAC chart. First, promote awareness and interest among parents and caregivers with a pictorial chart revealing the earliest changes of the enamel and the stages of breakdown. An educational tool depicting the consequences of dental caries, if not diagnosed or treated early, can be immensely beneficial in large-scale public health campaigns.¹⁴ Second, it should be a simple tool fitting into large healthcare campaigns involving all stakeholders to promote the immediate diagnosis of early lesions and report to the respective healthcare facility for further preventive efforts.

While ECC affects over 500 million children, early prevention at a global level is arduous because of the underlying shortage in the oral health workforce.¹⁶ According to the WHO, over 68 % of WHO member states are reported to have less than five dentists per 10,000 people and about 37 % are reported to have less than one (WHO Health workforce). Thus, health education and community engagement are essential for countering oral health inequalities. The WHO manual on ‘Ending Childhood Dental Caries’ recommends training caregivers, such as kindergarten and nursery staff to carry out ECC preventive actions, including early detection of dental caries. Additionally, the manual strongly recommends ECC prevention and oral health promotion in low-resource communities.² Hence a simple chart like MAAC chart will be immensely beneficial.

3. Core concept behind MAAC chart

In the past, self-reported instruments have proven to be an important focus for the prevention of diseases like cancer.¹⁷ Retrospective self-reports have numerous benefits, such as expeditious diagnosis and modification of easily administered and absolute measures. Self-reporting is often the most cost-effective method of preventing cancer progression. It has also been used for the early detection of oral cancer.^{18,19} The impact of interventions on the health of the target

audience can be illustrated using the Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) model. Reach refers to the potential proportion of the intended target population ultimately reached with an intervention; effectiveness refers to the beneficial and unintended effects the intervention achieves on key outcomes under real-world conditions, including cost-effectiveness; adoption refers to the uptake of the intervention by the staff, settings, and organizations; implementation refers to the degree to which the intervention can or will be delivered consistently and with fidelity over time and setting; and maintenance refers to the sustainability of intervention effectiveness in individuals and settings over time. The optimization of RE-AIM is aided by maximizing the acceptability and feasibility of the intervention tool.^{20,21} The MAAC chart was developed in alignment with RE-AIM to expedite ECC prevention.

Signs, prompts, and symbols are common means of changing societal behavior. However, the use of ‘warning signs’ is not new. In the past, warning signs have proven effective in facilitating the early diagnosis of cancer or heart attack.²² The MAAC charts illustrate the consequences of untreated ECC and motivate parents to report to the dentist immediately.

4. Development of the MAAC chart

The concept of MAAC charts emerged from (1) the idea that EH/ED is the primary risk factor for ECC and (2) the lessons from the first and second (unpublished data) Sustained Anticipatory Guidance cohort.¹¹ In Phase II of the Sustained Anticipatory Guidance (SAG) cohort,²³ the need for a tool to be provided to the parents/caregivers emerged to inform/report to the team as soon as the tooth erupted into the oral cavity. It is emphasized to the parents/caregivers during the anticipatory guidance session during recruitment (before teeth erupt) to report to the cleft clinic if ED/EH is observed on the enamel surface as a priority. Many infants in the first cohort¹¹ exhibited caries lesions (*both cavitated and non-cavitated*) in less than three months of tooth eruption follow-up, which led to the conceptualization of a picture-based tool that can aid in early diagnosis by parents/caretakers/non-dental healthcare professionals. Therefore, the MAAC chart is based on three important pillars: ‘early diagnosis,’ ‘self-reporting,’ and ‘early prevention.’

5. Description of the MAAC chart

The MAAC chart was developed by the authors (named after the first alphabet of the first name of five authors of this paper) to educate all stakeholders. These charts illustrate the clinical pictures of various stages of ED/EH patterns (demarcated and diffused opacities on various maxillary or mandibular teeth) and the early cavitated stages of ECC. The chart appears as a collage of pictures organized as individual sets of incisors and canines. Parents were encouraged to dry the infant's suspected tooth surface with cotton and compare those surfaces with clinical pictures in the charts. If an infant's newly erupted tooth/enamel showed similar changes as in the pictures, the parents were encouraged to report to the healthcare facility immediately for further guidance. Thus, these charts can be used as a reference by all stakeholders for early diagnosis of the earliest changes on the newly erupting tooth surface and, thereby, for self-reporting. The MAAC chart contained six rows of images (Fig. 1).

5.1. Mild

The first two rows show enamel with various non-cavitated lesions or EH/ED manifesting as diffuse patches or demarcated opacities. It also contains images of very small cavitated lesions on the enamel. These images depict the earliest changes in the ECC of the enamel soon after its eruption into the oral cavity.



Fig. 1. The MAAC chart illustrating different stages of ECC progression.

5.2. Moderate

If the mild disease is left untreated, it progresses to the moderate stage of the disease with increased cavitation and spreads to a larger area of the tooth enamel. Visual images make it easier for stakeholders to understand the spread of a disease.

5.3. Severe

The last two rows of the images show severe damage to the teeth if left untreated, resulting in root stumps. Almost the entire crown of the tooth is lost in most of the images presented here.

6. Preliminary experience on the usage of MAAC charts with children with cleft lip and palate

Institutional ethical approval was obtained prior to the study commencement. SAG was first tested in a small cohort of children with clefts, and promising results have been reported.¹¹ Subsequently, SAG was tested on a cohort of 85 infants under the Smile Train Oral Health Program (STOP) (Saikia A, unpublished). It involved the following steps: early recruitment of the participants; motivational interviewing (MI) of primary caregivers; oral health education by audio-visual aids and demonstration; providing oral hygiene aids in the form of sterile gauze pieces packed in color-coded envelopes to wipe the gums of children; reinforcing the same with pictorial representation on the envelopes; providing finger toothbrush and non-fluoridated toothpaste after the eruption of the first tooth and confirming the same via telephone calls, SMS, or follow-up visits; and continuous monitoring and evaluation with an application of fluoride varnish wherever necessary (effect of sustained interventions). Frequent follow-up was impossible owing to the poor economic status of most patients seeking treatment for cleft lip/palate, which served as a potential barrier to early diagnosis and intervention. Thus, the MAAC chart was primarily developed to promote the early diagnosis of EH/ED by parents/caregivers. These charts provided health coaching to parents and caretakers and were used as a

reference tool for the parental reporting of EH/ED. Among the cohort of 85 infants enrolled in the SAG program, nearly 60 % of the parents reported back by sharing a photograph of the infant's teeth or contacting the pediatric dentist in the cleft clinic as soon as the teeth erupted or when they were suspicious about changes on the enamel surface. The photograph was re-examined by pediatric dentists, and parents were encouraged to visit with their infants for fluoride varnish application and anticipatory guidance reinforcement. These charts aided significantly in the early diagnosis of ED/EH, facilitating remineralization of non-cavitated lesions and preventing further breakdown of the tooth structure.

7. MAAC chart into mainstream overall health initiatives

The coherent and comprehensive integration of the MAAC chart into vaccination visits and mainstream health initiatives can be a potential game-changer for the early diagnosis of ECC. Such integrations will allow the creation of large-scale awareness and early diagnosis opportunities and can significantly aid in early noninvasive, cost-effective, simple chair-side interventions for the earliest changes on the enamel surface. These charts were constructed to show the different ECC stages, starting from the earliest changes. All stakeholders can easily familiarize themselves with this chart and play a major role in the early identification of ECC. The involvement of multiple stakeholders in the early diagnostic process might pave the way for a fundamentally different approach to the early diagnosis of ECC. Watt quoted, "In high-income countries, the current treatment-dominated, increasingly high-technology, interventionist, and specialized approach is not tackling the underlying causes of disease and is not addressing the inequalities in oral health." and "In low- and middle-income countries (LMIC) dentistry is often unavailable, unaffordable, and inappropriate for the majority of these populations, but particularly the rural poor."¹⁰ Hence, a fundamentally different approach is required, and the use or implementation of a MAAC chart could be one of these steps.

8. Future underway

The MAAC chart can also be used as a warning label on the covers of toothpaste boxes, toothbrushes, and more, to create awareness as well as for disease control. Warning labels on cigarettes and octagonal nutritional warning labels on food and drink products have been shown to be effective in the past.²³

9. Conclusion

In summary, the MAAC charts showed excellent concordance in reporting early changes in ECC or EH in a cohort of 85 infants in SAG (Phase II - Unpublished data). In addition, MAAC charts are inexpensive, easy to understand, and easy to use for the early diagnosis of ECC. Although preventable, ECC persists with a high prevalence, reflecting widespread social and economic inequalities. It remains largely untreated in many LMICs because treatment costs exceed available resources. Creating useful resources, such as MAAC charts, is the first step in addressing the ongoing neglect of oral health in global health policy and prioritizing ECC and Oral diseases among other NCDs in global health research.

Authors' contribution

AS and MSM contributed equally to design, conceptualization, data curation, formal analysis, writing original manuscript, revision, submission, gave final approval and agrees to be accountable for all aspect of work ensuring integrity and accuracy. ASK, JC and MD critically revised manuscript for important intellectual content, gave final approval, and agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Role of funding source

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Ethics committee approval

Not applicable.

Declaration of competing 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.

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