Differential diagnosis, three-dimensional imaging aspects and interceptive orthodontic management of molar–incisor malformation

Fernanda Gabriela de Fátima Vieira, Andréa Vaz Braga Pintor, Aline Corrêa Abrahão, Antônio Carlos de Oliveira Ruellas, Maria Augusta Visconti, Laura Guimarães Primo

ABSTRACT

Introduction: Molar–incisor malformation is a condition described in 2014, with few reports in the literature and characterized by atypical root formation in incisors and first permanent molars. Case Report: We report a case of an 8-year-old patient with central incisors and upper and lower first permanent molars with short roots and open apexes, situation not compatible with the chronological age. The patient was evaluated clinically, radiographically, and by blood tests. Anatomopathological analyses of a primary tooth were performed. Computed tomography (CT) was used to evaluate root development of first permanent molars and incisors and compare, by superimposition, the radicular aspect of affected with unaffected teeth of a control patient of the same sex and age.

Clinically, the patient presented tongue-thrust habit, central incisors with premature contact and abnormal mobility, and enamel hypoplasia at teeth #8 and #24. Imaging exams showed teeth #3, #8, #9, #14, #19, #24, #25, and #30 with short roots and open apexes. One year follow-up CT images evidenced absence of root development of these teeth and thin roots walls, especially at the incisors. Interceptive orthodontic treatment with fixed palatal crib was performed. Conclusion: This report showed the importance of early diagnosis and treatment of molar–incisor malformation patients.

Keywords: Dentition, Molar, Oral, Pathology, Permanent, Tooth abnormalities, Tooth diseases

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INTRODUCTION

Dental anomalies are caused by complex interactions between genetics, epigenetics, and environmental
factors during the long period of dental development, and may manifest individually, as a group or as a whole [1]. Morphologically, tooth development begins with thickening of the dental epithelium to form a structure known as dental lamina. Within this band of thickened epithelium, the cells begin to proliferate and invaginate in certain positions to form the placodes, leading to the odontogenesis stages of bud, cap, and bell [2]. The epithelial–mesenchymal interaction is a normal and necessary event during odontogenesis [3], being susceptible to errors due to the complexity of the molecular processes involved.

Molar–incisor malformation (MIM) or molar root–incisor malformation (MRIM) is a condition described in 2014 [4] and characterized by atypical root formation in incisors and first permanent molars. Few reports are found in the literature [4–12]. Its etiology remains unknown and the phenotype varies according to its severity [7]. As clinical and imaging aspects are observed first permanent molars and, in some cases, primary second molars with normal crowns and thin, narrow, short, or even absent roots. Meanwhile, upper central incisors may exhibit, in addition to the abnormal root formation, hypoplastic enamel areas near the cervical third of the clinical crowns [4]. The dental team should be aware of this condition, aiming to perform the correct diagnosis, treatment plan, and control in order to prevent infections, painful conditions, and early loss of affected teeth [7].

The objective of this study was to present the clinical, radiographic and tomographic aspects, and the unprecedented three-dimensional (3D) superimposition images of first permanent molars and incisors affected by MIM, comparing them to those of an unaffected patient, highlighting the differential diagnosis, clinical and orthodontic interceptive management.

CASE REPORT

This report was approved by Ethical Committee of Hospital Universitário Clementino Fraga Filho—Universidade Federal do Rio de Janeiro (Opinion Number 3.451.539) and prepared according to the CARE Statement (CARE-Statement.org). Teeth are designated with the Universal Numbering System.

An 8-year-old black male patient was referred to Pediatric Dental Clinic of the Department of Pediatric Dentistry and Orthodontics of the Universidade Federal do Rio de Janeiro (UFRJ), by the Unified Health System (SUS), due to “a possible dentin alteration characterized by differentiated root formation in permanent teeth.”

Medical history

Medical history during pregnancy could not be confirmed, although the adoptive parents have reported abortion attempts. General health, after birth, was considered to be good by clinical and laboratory routine tests (Hemogram, Iron, Vitamin B12, T3, FT4, TSH, Vitamin D, and Folic Acid), assessments by the pediatrician. The parents presented the exam results within the normal standards and medical report at the initial dental appointment.

Dental history

Parents reported object-biting habit and no previous history of dental trauma.

Clinical examination

On general physical examination we observed that the patient had the height and weight relationship compatible with age, according to the growth curves proposed by the World Health Organization and confirmed at the medical report.

At intraoral clinical examination it was observed that the patient was in the first transitional period of mixed dentition, with overbite decreased due to tongue-thrust habit and short overjet, causing premature contact between the upper and lower permanent central incisors, which also presented with a slight degree of mobility. Caries lesions were not observed. Both permanent central incisors presented white lesions compatible with fluorosis. Enamel hypoplasia was observed on teeth #8 and #24 on their mesial and buccal surfaces, respectively (Figure 1). Periodontal examination showed no changes in probing depth.

Radiographic findings

The panoramic radiograph showed central incisors and upper and lower first permanent molars with short roots and open apexes (Figure 2), evidencing that the dental development was not compatible with the chronological age.

Differential diagnosis

The diagnostic hypotheses for the altered pattern of root formation were Hypophosphatasia, Dentin Dysplasia Type I, MIM and Papillon–LeFréve syndrome. The latter was discarded since there were no episodes of fever, spots

Figure 1: (A) Initial clinical aspect: decreased overbite. (B) Enamel hypoplasia presents on teeth #8 and #24, on the mesial and buccal surfaces, respectively.
on the skin, and the neutrophils count was within normal limits (2,580/mm³). Hypophosphatasia hypothesis was ruled out since a new blood test showed normal levels of alkaline phosphatase (573 U/L). The involvement of only one group of teeth and the presence of enamel hypoplasias in upper and lower permanent incisors associated with the root malformation process led to the diagnostic of molar–incisor malformation.

Dental management

The patient was submitted to dental prophylaxis and topical application of fluoride. Oral hygiene instructions and dietary advice were given by dental team. Occlusal adjustment was performed with a diamond bur on the lingual surfaces of the #8 and #9 teeth, in order to remove the premature contact with antagonists, which could be influencing in the tooth mobility observed. Then, interceptive orthodontic treatment was started with a fixed palatal crib and the patient was referred for speech therapy, aiming to prevent and correct the tongue-thrust and object-biting habits. After six months, it was possible to observe a significant improvement in the overbite and overjet (Figure 3); however, mobility in the upper and lower permanent central incisors remained, probably due to the low root formation associated with these teeth.

Anatomopathological findings

Both primary mandibular lateral incisors were surgically removed since the physiological rhizolysis did not occur, even after the eruption of the successor permanent teeth. Although unaffected by MIM, the extracted primary teeth were submitted to anatomopathologic analysis. The gross specimen evaluation of teeth did not show any surface or shape alterations. One tooth was decalcified in 4.13% ethylenediaminetetraacetic acid (EDTA), hematoxylin-eosin stained, and microscopically evaluated in a light microscope (Olympus BX41, Tokyo, Japan). Normal tubular dentin was observed, underlined by a columnar odontoblastic layer. Inside the pulp chamber a loose connective tissue was present with blood vessels and nerves. The lack of dentin alterations suggested that, in this patient, MIM was only associated to the permanent dentition.

Tomographic findings

Cone-beam computed tomography (CBCT) was performed one year after the last panoramic radiograph, with the purpose of monitoring and accurate volumetric evaluation of the affected teeth and adjacent structures. The images obtained showed no evolution in the root formation process of the permanent teeth in question, first molars and incisors. It was possible to observe that the affected teeth presented thinned dentinal faces at the root portion, being this aspect still more accentuated in the incisors. Teeth #8 and #9 presented large pulp chambers, with a hypodense image associated with the mesial root surfaces in cervical and middle thirds (Figure 4), suggesting an incomplete formation/resorptive process. In the sagittal reconstructions it was possible to detect the maintenance of the spaces corresponding to the periodontal ligaments, incomplete radicular apexes formation in all the involved teeth and alteration of the root morphology in the incisors, characterized by enlarged pulp chambers and root canals.
Tomographic images superimposition

In order to evidence the magnitude of the present root malformation, the CBCT images were superposed using the ITK-Snap v. 2.2 (Penn Image Computing and Science Laboratory, Philadelphia, PA; http://www.itksnap.org/) and 3-D Slicer (http://www.slicer.org/). Segmentations and 3D surface models were created for upper incisors and first permanent molars. Best-fit overlay of the images was performed comparing the images obtained in the present case with those already existing, acquired in an image bank, of a patient of the same sex and age (control). The images were leveled at the cementum enamel junction. It was observed that permanent first molars and incisors presented incomplete root formation, with open and wide root apexes. For the incisors, it was also observed an altered proportion between crown and root size (Figure 5).

DISCUSSION

The process of permanent tooth formation begins in intrauterine life and any serious systemic alterations occurring between pregnancy and the first two to three years of life may affect the formation of first molars and incisors [7], as observed by Lee et al. (2014) [4], who described the process of atypical root formation in these teeth and called it as MIM. In this same year, Witt et al. [6] reported two cases of patients with poor root formation in the first permanent molars, who had a medical history marked by hospitalization due to premature birth and severe infection at nine months old. Alterations, such as meningitis, myelomeningocele, chronic renal failure [10], and severe health problems in the head and neck regions at the onset of life, were also observed in patients with MIM [7].

In the present case, even in the absence of systemic factors associated with the general health of the patient during his first three years of life, there were reports of a troubled gestation. This fact suggests that may exist an association between the environmental stressors experienced in his early life and the root molar malformations and incisor constrictions [7]. It is known that genetic and epigenetic factors can also influence the process of root development [3, 7, 11], but one limitation of the present report was the impossibility of carrying out genetic tests.

The worldwide prevalence of this newly described condition is still unknown [7]. Based on all the studies published to date [4–12] this seems to be the first report of MIM in a child in South America. Bilateral symmetry [8] and variable phenotype according to its severity are characteristics of MIM. The present patient showed bilateral symmetry involvement in addition to the poor root formation of the permanent first molars and incisors. Furthermore, an aspect of taurodontism at the lower first permanent molars, as described by Brusevol et al. (2017) [7], was observed. However, the second primary molars were unaffected, although these teeth may, eventually, be affected by this condition [4, 7, 8, 10], since their formation process occurs at a period similar to that of incisors and first permanent molars.

The altered characteristics evidenced in two-dimensional (2D) radiographic examinations are sufficient to detect this condition [8]. However, CBCT which provides more accurate root measurements and greater sensitivity and specificity than panoramic or 2D radiographs in detecting root resorption [13] is an important tool for the diagnosis and strategic planning of affected teeth by this condition [5, 6, 8, 11]. The overlapping and segmentation of the tomographic images allowed comparing the radicular portions of affected teeth by MIM with one from a control patient without the alteration. Even though, due to ethics limitation, it was not possible to match the case with a patient with similar crown proportions, the superimposed images enabled the visualization, in detail, of the irregularities present on the root surfaces, in a way not yet described in the literature. Although alterations in the pulp chamber have already been observed in some studies [5, 8, 11], it is important to emphasize the presence of other alterations, such as exacerbated thinning of the dentinal faces of the root portion, enlargement of the root canal, alteration in the root morphology (rounded aspect), and resorptive aspect of the root dentin.

Interceptive orthodontic management, performed during the establishment of the permanent denture in a patient with different types of root malformation, was shown to be relevant [14], by allowing the interception of deleterious habits and promoting improvement in overbite and overjet. We believe, without the orthodontic and speech intervention, that the maintenance of the permanent incisors with MIM in their respective arches would be compromised, due to the overload produced by the tongue-thrust habit.

CONCLUSION

Molar–incisor malformation is an unusual condition and reports using new methodologies, such as the overlapping of tomographic images, are important to elucidate the knowledge of other professionals, allowing
a better understanding of this alteration, early diagnosis, correct treatment approach, and preservation of such teeth, as well as for the establishment of the prevalence.

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