Guidance for Permanent First Molar Extraction in Molar-Incisor Malformation: Report of Two Cases

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ABSTRACT

Molar-incisor malformation (MIM) is a newly described dental developmental anomaly that predominantly affects primary second molars, permanent first molars, and, in some cases, permanent central incisors. Diagnosis is usually made upon radiographic examination. The molars usually present with significant cervical constriction, flattened pulp chambers, and absent or thin, short, and narrow roots, whereas the incisors usually exhibit coronal dilaceration. Loss of these compromised teeth in the long term may be inevitable. Thus, clinicians should be aware of this condition and the factors to consider to advise their patients as early as possible. The purpose of this paper is to present two cases of MIM and discuss the factors clinicians should take into consideration to make a care plan in these cases. (**J Dent Child 2022;89(1):29-35**)

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Molar-incisor malformation (**MIM**) is a relatively newly described dental developmental anomaly that predominantly affects the primary second molars, permanent first molars, and, in some cases, permanent maxillary central incisors.[1] Given that the roots of the molars are mainly affected, the term "molar root incisor malformation" has also been suggested.[2]

The etiology of MIM is unknown; however, research has suggested an association with conditions that affect the child in the first year of life.[2,3] The most common medical conditions reported to be associated with MIM are premature birth (17.2 percent), meningitis (12.6 percent), administration of antibiotics (9.2 percent), spina bifida (8.0 percent), stroke (6.9 percent), hydrocephalus (5.7 percent) and PHACE (posterior fossa anomalies, hemangioma, arterial anomalies, cardiac anomalies, and eye anomalies) syndrome (4.6 percent).[4] Fewer cases have been associated with bacterial infections, cranial injury, renal disease, seizures, brain abscess, teratoma, ciliary dysfunction, cerebral palsy, developmental delay, jaundice, meconium aspiration, hearing loss, diabetes, asphyxia and low birth weight.[4]

Based on the microscopic analysis of teeth with MIM, researchers concluded that the formation of the apical pulp and dental follicle of the teeth is likely occurring at the time the medical condition or the environmental insult happens, which subsequently results in the malformation. Radiographically, the permanent first molars and sometimes the primary second molars present with significant cervical constriction, flattened pulp chambers, and absent or thin, short, and narrow roots.[1,3] Periapical periodontitis in the

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absence of dental caries has also been described.[3] Clinical manifestations are uncommon in MIM and usually the cases are diagnosed as a result of an abnormal radiographic finding. However, labial curvature consistent with coronal dilaceration and the presence of a cervical constriction of the crown of the incisors can be indicative of MIM.[1,3]

No specific treatment for MIM cases has been suggested in the literature.[4] Many have suggested monitoring of the teeth until they become symptomatic, but the majority of the cases have eventually resulted in extraction of the affected molars.[3] If extractions are performed in a timely manner, as opposed to waiting until the affected teeth become symptomatic, the patient may benefit from replacement of the extracted teeth with healthy second molars.[6] For this reason, it is imperative to be aware of the different factors that clinicians should take into consideration to develop an appropriate treatment protocol for MIM cases.

The purpose of this paper is to present two MIM cases and discuss the factors clinicians should carefully consider to make optimal care plan decisions for children diagnosed with the condition.

CASE REPORTS

CASE 1

An eight-year-old African American girl presented to the Children's Hospital of Wisconsin Midtown Dental Clinic, Milwaukee, Wis., USA, for a routine oral examination. Her medical history was positive for a ventricular septal defect and several recurrent cutaneous herpes simplex virus-2 infections as an infant. Viral meningitis was suspected and the patient was treated with high-dose intravenous acyclovir. An magnetic resonance imaging (MRI) was completed at one month old to evaluate for meningitis, but all findings were within normal limits. The child did not present with any signs of neurological disorder or developmental impairment in the following years, had no known allergies, had a complete vaccination record and had routine annual check-ups with her pediatrician.

The patient had a history of routine dental care and presented to the clinic with no dental complaints. Clinical examination revealed an early mixed dentition that was age-appropriate, soft tissues within the normal limits, and several restorations on primary molars. No new caries were diagnosed upon clinical examination, and all existing restorations appeared within normal limits. The patient presented with a bilateral Angle Class I molar occlusion and Class III canine relationship. Overjet and overbite could not be accurately evaluated at this time, as the maxillary incisors were not fully erupted. Bilateral bitewing radiographs (Figures

Figure 1. Case one right bitewing radiograph. Note the cervical constriction and abnormal root morphology of the permanent mandibular first molar and incipient carious lesion on its mesial surface.

Figure 2. Case one left bitewing radiograph. Note the cervical constriction and abnormal root morphology of the permanent mandibular first molar and misplacement of the mandibular second premolar.

Figure 3. Case one panoramic radiograph. Note the cervical constriction and abnormal root morphology of the permanent mandibular first molars as well as the thin roots and constriction of pulp chambers on the permanent maxillary first molars, which is consistent with molar-incisor malformation.

1 and 2) and a panoramic radiograph (Figure 3) were taken to complete the periodic oral examination. Radiographs showed cervical constriction and abnormal root morphology of the permanent mandibular first molars, which were consistent with MIM. An incipient carious lesion was also noted on the mesial surface of the permanent mandibular right first molar. The permanent maxillary first molars exhibited thin roots with constriction of pulp cavities. The tooth buds of both mandibular second premolars were distally misplaced, likely secondary to the thin roots of the primary second molars. The maxillary central incisors exhibited normal morphology both clinically and radiographically.

The patient's parents were informed of this incidental radiographic finding and possible treatment options for the teeth presenting this malformation. The options suggested were: (1) to monitor the affected teeth until they were lost and then decide on a definite treatment using orthodontics or implants or (2) extraction of the permanent mandibular first molars at this age to allow for molar substitution with eruption of permanent second molars in their place. The parents decided to monitor the teeth and fluoride was applied to promote the arrest of incipient carious lesion on the permanent mandibular right first molar.

The child returned to the office nine months later with a chief complaint of tooth pain. Clinical and radiographic examination revealed significant progression of the incipient carious lesion on the permanent mandibular right first molar (Figure 4). The child's pain history and vitality testing were consistent with a diagnosis of irreversible pulpitis. The parents were informed of the different treatment options and decided to have the tooth extracted, given the questionable long-term prognosis of root canal therapy on molars affected by MIM. Extracting the first molar at this age could allow for tooth substitution and improvement of Class III tendency, with eruption of the permanent second molar in a more mesial position. Extraction of the permanent mandibular right first molar was done under nitrous oxide sedation by an oral surgeon.

The permanent mandibular left first molar was also extracted after an evaluation with an orthodontist, to allow for symmetry and correction of the Class III tendency. The patient is scheduled to visit the clinic for periodic oral examinations, prophylaxis and fluoride treatments every three months to detect any carious lesions early, monitor the status of the MIM-affected teeth and guide the patient adequately during orthodontic treatment.

Figure 4. Case one right bitewing radiograph nine months later. Note the progression of the carious lesion on the mesial surface of the permanent mandibular first molar with pulp involvement.

CASE 2

A seven-year-old Caucasian girl presented to a private dental practice in Athens, Greece, for periodic oral examination. Her medical history revealed infection with enterovirus 40 days after birth, which infected the central nervous system and resulted in viral meningitis. The patient developed a fever, was hospitalized and received intravenous antibiotics. In addition to that, she developed a seizure during her hospitalization and an MRI was performed, which was within normal limits. The patient has been healthy ever since, has no known allergies and is up-to-date with all vaccinations appropriate for her age.

The patient had annual dental check-ups for prophylaxis and topical application of fluoride. The clinical examinations in previous years were within normal limits. At the most recent dental visit, the patient presented with mixed dentition (Figure 5), was caries-free and had some calculus on the lower incisors. She had a flush terminal plane molar relationship, Class I canine relationship and a three-mm anterior open bite. At a later routine examination, the permanent maxillary incisors had erupted and the patient presented with an excessive overjet (Figure 6), with no history of thumb-sucking habit or anterior tongue thrust. The patient presented with lip incompetence as a result of the malpositioned incisors.

Figure 5. Case two clinical frontal photo showing the malposition of the newly erupted maxillary central incisors.

A panoramic radiograph (Figure 7) revealed cervical constriction and flattened pulp chambers on all the permanent first molars and the primary second mandibular molars. The roots of the permanent first molars as well as the distal buccal roots of the primary second maxillary molars were either missing or malformed. Radiographs confirmed that the patient was congenitally missing the permanent maxillary lateral incisors and had a crown dilaceration in the permanent maxillary central incisors. Collectively, the findings were consistent with MIM and the parents were informed of the different treatment options that would require a long-term and multidisciplinary dental approach. They decided to restore the incisors to maintain the teeth as long as possible, since the patient also presented congenital missing laterals. The orthodontist suggested extraction of the affected permanent first molars at an early age to allow for substitution by second molars. The patient is currently under follow-up care every six months to provide preventive care, monitor the affected teeth and manage any tooth loss early.

Figure 6. Case two clinical lateral photo showing excessive overjet of the central incisors.

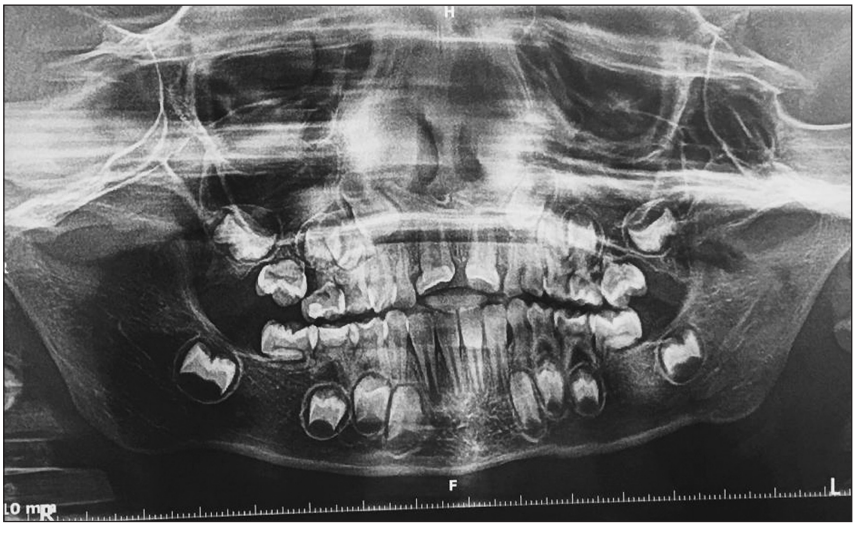

Figure 7. Case two panoramic radiograph. Note the cervical constriction, flattened pulp chambers and absent roots on all permanent first molars. The primary second molars were also affected. Note the congenitally missing maxillary lateral incisors and crown dilaceration of the permanent central incisors.

DISCUSSION

MIM is a newly described dental defect often resulting in premature loss of permanent teeth. Early diagnosis and provision of anticipatory guidance to parents regarding treatment options are necessary to achieve long-term dental arch stability and function.

Obtaining a thorough medical history can be a crucial component in the diagnosis of any potential dental developmental anomaly. Approximately 93 percent of MIM cases had a contributory medical history during the first years of life.[4,7] Both cases presented were associated with viral meningitis in the first year of life, which has been reported as the second most common medical condition associated with MIM. Based on the microscoping analysis of the teeth with MIM, researchers concluded that the neurological disorder or medication intake in the first year of life affects the signal for the formation of the pulpal floor of the teeth that are developing at that time.[5] Thus, when the medical condition or environmental insult associated with the dental defect happens at birth, the teeth more frequently affected are likely to be the permanent first molars and the primary second molars. When it occurs after three to four months of age, the permanent incisors can also be affected.

Cases of MIM should be differentiated from other conditions with similar radiographic findings. Dental trauma or infection of primary teeth, extreme orthodontic forces and impacted teeth or cysts apply pressure on developing permanent teeth, leading sometimes to localized enamel defects or root resorption.[8] These cases can be differentiated from MIM in that they usually present signs of root resorption on multiple teeth and they do not have a history of trauma or orthodontic treatment. Dentinogenesis imperfecta and dentin dysplasia are two hereditary conditions that often present missing roots and/or cervical root constriction.[2] However, these conditions affect all teeth in both dentitions and can thus be differentiated from MIM cases. Some other rare conditions, such as tumoral calcinosis, spomastrime dysplasia, Singleton-Merten syndrome 1, Bardet-Biedl syndrome 1 and Kenny-

Caffey syndrome, present with abnormal root formation and should be included in the differential diagnosis.[2]

Clinical manifestations are uncommon in MIM; however, tooth misalignment, hypoplastic enamel notch, tooth impaction, ectopic eruption, space loss, early exfoliation, tooth pain and abscess can be indicative of MIM.[1,7] In the current report, only the second case presented clinical findings with ectopic eruption of the permanent maxillary right first molar and labial curvatures with a V-shape notch on the central incisors. The curvature is compatible with coronal dilaceration, which can occur when a traumatic event happens during the formation of the permanent tooth.[9] Diagnosis is always confirmed based on the radiographic findings of cervical constriction, flattened pulp chambers, and absent or thin, short, and narrow roots.[1,3]

Treatment options vary based on a number of factors (Table). Clinicians should decide to extract or maintain the affected teeth considering all these factors collectively. The type of treatment modality for children should be carefully considered, given that it may require advanced behavioral guidance. For example, extraction of permanent first molars in young children may require some type of sedation to help the child cope with the procedure.[10]

Not all cases of MIM are equally affected. Depending on the time, duration and intensity of the event that caused the malformation, the severity of MIM may vary. Thus, the teeth may present some root formation similar to the first case of the present report or may have total root absence, as in the second case. Overall, more severely affected teeth have a poor long-term prognosis and extraction is a reasonable treatment option to allow for orthodontic management or mesialization of unaffected second molars.

The state of the affected teeth should be taken into consideration when treatment planning MIM cases. When the affected teeth are intact, monitoring alone may be appropriate. In the literature, there is no report of spontaneous premature loss of MIM-affected teeth as a result of their lack of roots and unfavorable crown-root ratio. However, they often develop periapical lesions or become painful, requiring some type of management. Thus, when the affected teeth present caries, hypoplasia or periodontal issues, clinicians may decide to extract the tooth.

Few cases of endodontic treatment of MIM-affected molars have been reported in the literature as a very complicated procedure as the teeth may present multiple accessory canals and irregular root morphology.[11,12] In addition to that, although short-term results were satisfying, the teeth presented with periapical lesions and root resorption one to two years later.[12] Thus, it seems that endodontic treatment of MIM cases has limitations and should be considered in rare occasions.

Substitution of permanent first molars with permanent second molars can occur spontaneously when the patient is between eight to ten years of age at the time of the extraction.[13] More specifically, spontaneous space closure occurs when the furcation of the permanent second molar is not fully formed and is more favorable if the second molar has mesial inclination and the third molars are present.[13] Spontaneous space closure more often occurs in mandibular molars due to their mesial inclination.[13]

The number of teeth affected should be considered in MIM cases when deciding toward the extraction or maintenance of first molars. Often, extraction of a permanent molar requires a compensating extraction of the opposing tooth and/or a balancing extraction on the opposite side of the arch to avoid supraeruption or midline drift, respectively.[10] Thus, when more molars are affected, they can all be extracted without adverse effects such as supraeruption of the opposing tooth or midline deviation. In cases where only one tooth presents a malformation, it usually has a milder phenotype and monitoring may avoid extraction of sound teeth. On the other hand, when multiple teeth need to be extracted, clinicians need

Table. Factors Associated With Treatment Options for Molar-Incisor Malformation (MIM) Cases That Should Be Considered Collectively Based on the Decision to Extract or Maintain Affected Teeth

Factors	Extraction	Observation
Severity of MIM	Less than two-thirds of root present	More than two-thirds of root present
State of affected teeth[12]	Pulp involvement, non-restorable	Sound
Permanent second molars[10]	Non formed roots (<9 years old)	Formed roots (>9 years old)
Number of teeth affected[13]	Multiple	One
Skeletal vertical[16]	Open bite, hyperdivergent planes	Deep bite, flat planes
Congenital missing teeth (third molars)[17]	No	Yes
Sagittal molar relationship[19,20]	Class II (maxillary molars) Class III (lower molars)	Class I
Incisor position[21]	Proclined	Retroclined

to consider carefully the other factors, such as the skeletal profile, molar relationship, crowding, etc.[14,15]

Skeletal profile is crucial in orthodontic cases to determine if extraction of teeth will have a significant impact on the lower face height in the long term.[16] Patients with an open bite and hyperdivergent skeletal pattern usually allow for the extraction of teeth without significant decrease in the vertical dimension in the long term.[17] However, extractions are not usually indicated in cases with deep bite and flat horizontal planes.[17] Thus, the skeletal pattern should be taken into consideration in MIM cases when deciding between the extraction or monitoring of the affected molars.

Another factor that may impact the decision to extract teeth in MIM cases is the coexistence of congenitally missing teeth. Maintenance, instead of extraction of affected teeth, is usually the treatment of choice when other teeth are missing in order to minimize the number of teeth missing from the arch. In the second case, the patient presented with congenitally missing lateral incisors; for this reason, the maintenance and build-up of the affected central incisors were chosen. The degree of space deficiency, as well as its location, should also be evaluated to determine if the extraction of teeth is an appropriate treatment option. Extracting an affected MIM tooth may help resolve the crowding by providing space for the alignment of the surrounding teeth.[18] However, if the crowding is located in the anterior region, extraction of an affected molar would not help much, as the available space will be located in a much more distal location.[19]

Sagittal molar relationship also plays an important role in the extraction of permanent teeth. Class I and III molar relationships usually require a compensating extraction of the maxillary antagonist tooth to avoid supraeruption.[10] In Class II molar occlusion, on the other hand, the extraction of the maxillary affected molars will help improve the malocclusion.[20] However, in cases of maxillary extracted molars, anchorage is very important to avoid mesial drift of permanent maxillary second molars to the extraction site.[19]

Finally, the position of the incisors and lips should also be considered. Retroclined incisors usually contradict extraction of mandibular molars.[19] Extraction of permanent teeth often results in significant changes to the the upper and lower lip position, which may cause noticeable changes in an individual's esthetics.[21]

In conclusion, MIM is a dental developmental anomaly that affects mainly the roots of the primary second molars, permanent first molars and permanent maxillary central incisors. Most cases have been associated with early-life medical conditions, especially those of the central nervous system. Early diagnosis and understanding of MIM are important, as it allows provision of anticipatory guidance to parents regarding possible complications and treatment options to prevent complications and guide dental development for long-term dentition stability.

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