Molar incisor malformation in six cases: description and diagnostic protocol

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Objective. The term molar-incisor malformation (MIM) has recently been presented in the scientific literature, where it is described as a condition with localized impaired root development. Here we present 6 recently discovered cases referred to our departments.

Study Design. The patients were enrolled in the study after referral and were examined clinically and radiologically. Two extracted teeth were further examined with micro–computed tomography or microscopy.

Results. Affected teeth were first permanent molars with hypoplastic roots, narrow pulp chambers, and a hypercalcified dentine layer cervical to the pulp chamber. Two of the cases also had cervical constrictions on the upper incisors. The patients were 8 to 12 years of age and healthy, but had experienced serious medical conditions of the head and neck region in their first year of life. Some of the cases had been referred because of acute infection and pain.

Conclusion. In 5 out of 6 patients, severe health problems in the head and neck region early in life may have been associated with root malformation in molars and incisors. Patients with MIM need to be followed closely, and extractions should be planned at the right time to avoid unnecessary infection and pain in addition to orthodontic problems. (Oral Surg Oral Med Oral Pathol Oral Radiol 2017;124:52-61)

The formation of permanent first molars and incisors starts around the time of birth, and serious medical insults to the child during the first 2 to 3 years of life may affect tooth development. Molar-incisor hypomineralization (MIH) is a well-known but poorly understood condition affecting the mineralization of permanent first molars and incisors in 2.4% to 40% of individuals, according to worldwide prevalence studies.[1] Recently, a new condition has been described that affects the roots of the same teeth. So far, only 6 publications, all published within the last 2 years, have described the condition.[2-7] In these publications, the terms root malformation, molar-incisor malformation (MIM), and molar root-incisor malformation have all been used to describe the phenomenon.

From these publications, the condition is characterized by disturbances in root development of all first permanent molars. The roots are very slender and malformed and are sometimes absent. In some patients, there are constrictions located in the cervical part of the crown of the permanent incisors. There are also cases in which the roots of the second primary molars are affected.

Tooth development is tightly genetically controlled, starting from thickening of the epithelium to form the dental lamina.[8] The cells proliferate to form the dental placode, which continues through the bud, cap, and bell stages, induced by signaling interactions between the epithelium and the mesenchyme. In the bell stage, cells differentiate into ameloblasts and odontoblasts, followed by matrix secretion and mineralization of the crown.[9] Root development, which is also tightly genetically controlled, extends from Hertwigs's epithelial root sheath (HERS). The HERS is formed from the cervical loop, which consists of the inner and outer enamel epithelium at the neck ring of the dental papilla.[10] The exact decisive component that triggers the HERS to initiate root formation is not well known, but Sakano et al. recently reported that the outer enamel epithelium cells had higher proliferative and migratory activity than the inner enamel epithelial cells before forming the HERS.[11] The HERS cells are then thought to initiate odontoblast differentiation from mesenchymal cells and to determine root size

Statement of Clinical Relevance

Molar incisor malformation is a newly recognized condition. The dental team should be aware of this condition in order to make the correct diagnosis and develop a control and treatment plan to avoid infection, pain, and early tooth loss in affected children.

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and shape.[12,13] Other authors have reported a novel cell population, the apical odontoblast, as being responsible for the initiation of root formation.[14] These cells lie apical to the HERS after crown formation and are dependent on the activation of β-catenin.[14,15] It is clear that disturbances in this finely tuned process might affect root development.

In this paper, we aim to describe 6 cases of root malformations that were recently referred to the Department of Paediatric Dentistry at the University of Oslo and to the Oral Health Centre of Expertise in Mid-Norway. The condition was unfamiliar, and differential diagnoses included a progressive resorptive process and a developmental defect. After observing the cases over time and performing histologic and micro−computed tomography (CT) examinations, we now know that all these cases demonstrate developmental disturbances of root development. There are no signs that indicate a resorptive lesion in any of the cases. We also hope to give a schematic guide to identify the condition in children with known serious medical conditions during the first years of life and a guide for describing and reporting the condition when discovered.

METHODS

Patients

These patients were all referred to our department or to the Oral Health Centre of Expertise in Mid-Norway from the public dental health service or from private general dentists. The patients' teeth and oral cavities were examined clinically and radiographically. Clinical images were taken at the first visit with a Canon EOS60 D camera with Canon MR-14 EX ring flash and a 100-mm Canon EF macro lens (Tokyo, Japan). Characterizations of the patients are summarized in Table I. Written informed consent was given by the patients' parents. Teeth are designated with the Universal Numbering System (the US tooth numbering system).

Histology

The extracted of the lower right first permanent molar from patient 1 was embedded in resin (Technovit 7100) without decalcification after rehydration and then sectioned in the buccolingual direction. Images were obtained with a Canon EOS60 D camera with Canon MR-14 EX ring flash and a 100-mm Canon EF macro lens, and a Zeiss SteREO Discovery.V8 stereomicroscope with an Axiocam 105 color camera (Carl Zeiss Meditec AG, Jena, Germany). Then 10-μm sections were made and mounted on glass slides. For visualization, hematoxylin was applied to the undecalcified surface for 3 minutes, slides were washed in distilled water and air dried, and eosin was applied for 3 minutes before washing and drying. The sections were evaluated under a Leica DMRBE microscope (Leica Mikrosysteme Vertrieb GmbH, Mikroskopie und Histologie, Wetzlar, Germany) and images were taken with an Olympus DP50 camera (Olympus Corporation, Tokyo, Japan) fitted to the microscope.

Micro-CT

The left mandibular first molar from patient 1 was scanned in a SkyScan 1172 (SkyScan, Aartselaar, Belgium) micro-CT with an image pixel size of 11.95 μm and an image resolution of 2000 × 1048 pixels. The 360° scans were obtained at 100 kV, 100 μA at 0.4° rotation steps with an additional aluminum (1 mm) and copper (0.05 mm) filter in the beam path.

The scans were reconstructed using the standard SkyScan reconstruction software (NRecon, v1.6.10.1). The following parameters were applied: smoothing of 2 pixels, beam-hardening correction of 25%, ring artifact reduction of 12, and an output attenuation coefficient range of 0.00 to 0.1.

RESULTS

Cases

A summary of the patient cases is given in Table I.

Patient 1

This 8-year-old female patient was referred to the university clinic because of painful lower first permanent molars on both sides with abnormal roots. The pain had been intermittent for 2 to 3 months, gradually worsening and occasionally preventing her from sleeping. The clinical and radiographic examination revealed narrow and underdeveloped roots, obstructed pulp cavities, and bone destruction down to the furcation areas (Figure 1). The right mandibular first molar demonstrated an apical radiolucency and a radiolucent area along the mesial surface of the mesial root all the way from the cervical to the apical margins (Figure 1). No marginal pockets deeper than 3 mm were probed at the time of examination, but the referring dentist had discovered marginal pockets deeper than 3 mm on both teeth earlier. The upper first permanent molars also showed underdeveloped roots. No bone loss was detected on the radiographs of the upper jaw. The 2 lower first primary molars showed taurodontism. The patient was healthy but had a medical record of brain blood clot at birth, which was treated with an anticlotting agent and antibiotics for 4 weeks under hospitalization. She had experienced occasional epileptic seizures up to the age of 7 years. These were treated with midazolam. The most painful tooth, the lower left mandibular