A CASE OF AMELOGENESIS IMPERFECTA OF DECIDUOUS AND ALL PERMANENT TEETH

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Abstract

We experienced a case with severe enamel defects of both the deciduous teeth and all the permanent teeth. In order to clarify the etiology of enamel defects in this patient, we performed a DNA analysis in addition to conventional examinations. Although we suspected a variety of systemic factors causing enamel defects, there was no evidence suggesting disturbances of amelogenesis. In the present case, we suspected a mutation in the amelogenin gene and performed nucleotide sequencing of the exons of the amelogenin gene, but we could not find any evidence of mutation. We suggest that a mutation of some other gene related to enamel formation or the adventitious factors contributed to the amelogenesis imperfecta in this case.

Key words: Amelogenesis imperfecta—Enamel hypoplasia—Amelogenin gene—PCR method—DNA analysis

CASE REPORT

The patient was a 14-year-old girl. She was rather slim, but her nutritional state was normal. There were no abnormalities in her face, hair, sweat glands, or nails. Her height was 152.5 cm, and her weight was 39.0 kg. Both were within the range of the mean minus 1 SD for Japanese girls of her age. In 1986, she visited the Pediatric Dental Clinic of the Tokyo Dental College Chiba Hospital for the treatment of dental caries in all deciduous teeth. At the time of her first visit, she was 6 years and 6 months old. During her gestational period, there were no abnormalities in either her mother or herself, and there was no history of impacting diseases, trauma, or medication. She was a normal term infant. At birth,
her mother was 29 years old, her birth weight was 3,250 g, and her height was 48.0 cm. The Apgar score was 9. After delivery, her growth was normal, and her nutritional state was good. She has had no specific diseases since birth. Examinations of genetic abnormalities in her parents, her elder sister, and other relatives revealed no similar dental abnormalities or any systemic ones.

Fig. 1 shows intra-oral photographs at the first visit. There was a defect of substance in the enamel on the labial, buccal, lingual, cuspid and occlusal surfaces of all of her maxillary and mandibular deciduous teeth; the cervical surfaces were intact. Maxillary and mandibular deciduous central incisors and mandibular deciduous lateral incisors were already gone. Therefore, the state of their crowns was unknown. The enamel of the mandibular permanent central and lateral incisors was hard and slightly rough with a “ground glass” feel when a probe was passed over the surface.

Fig. 2 shows intra-oral photographs of her maxillary and mandibular permanent posterior teeth on the right side; these were taken when she was 14 years old. Her permanent teeth were yellowish brown. Their enamel surfaces were rough, hard, and there was a defect in the tooth substance. Their dentin surfaces were softer than those of normal teeth. Occlusal attachment revealed enamel avulsion in the edges of permanent canines and in the occlusal, buccal, and lingual surfaces of permanent posterior teeth.

Fig. 3 shows intra-oral X-ray photographs of the mandibular permanent incisors and molars teeth on the right side taken when she
was 14 years old. The enamel of the cusp was defective, the enamel radiolucency of the proximal surfaces was high, and the junction of enamel and dentin was obscure. There were no abnormalities in the condition of the root formation, the pulp chamber, or the alveolar bone.

Table 1 summarizes the results of blood examinations. There were no abnormal findings in general, biochemical and endocrinological examinations. Because, there were no abnormal findings related to disturbances in amelogenesis, we suspected a genetic mutation and performed an analysis of the ame-

Fig. 2 Intra-oral views of the maxillary and mandibular permanent posterior teeth

Fig. 3 Radiographic appearance of the mandibular permanent incisors and posterior teeth
logenin gene contributing to enamel formation. In order to amplify exons 1, 2, 3, 4, 5, 6, and 7 of the amelogenin gene on the X chromosome by polymerase chain reaction (PCR), we used 7 sets of primers that amplify 250, 247, 215, 355, 194, 621 and 197 bp fragments of the wild type amelogenin gene. After amplifying each PCR fragment containing exons from the genomic DNA of the patient, we compared them with those of a normal subject. The size of each fragment was the same as those of a normal subject (Fig. 4). We subsequently determined the nucleotide sequences of each fragment of the patient. Comparison of the nucleotide sequences of the each fragment of the patient and the normal subject also showed complete accordance. This indicates that the amelogenin

Table 1  Blood examinations

<table>
<thead>
<tr>
<th>Items of examination</th>
<th>Normal range</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cell (RBC) ($\times 10^6/\mu l$)</td>
<td>3.8–4.8</td>
<td>4.12</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>12.0–16.0</td>
<td>12.5</td>
</tr>
<tr>
<td>White blood cell (WBC) ($\times 10^3/\mu l$)</td>
<td>4.0–8.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Protein, total (TP) (g/dl)</td>
<td>6.6–8.4</td>
<td>6.6</td>
</tr>
<tr>
<td>Bilirubin, total (TB) (mg/dl)</td>
<td>0.2–1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Alkaline phosphatase (ALP) (IU/l)</td>
<td>110–325</td>
<td>879</td>
</tr>
<tr>
<td>Glutamic-oxalacetic transaminase (GOT) (IU/l)</td>
<td>10–36</td>
<td>21</td>
</tr>
<tr>
<td>Glutamic-pyruvic transaminase (GPT) (IU/l)</td>
<td>0–50</td>
<td>7</td>
</tr>
<tr>
<td>Sodium (Na) (mEq/l)</td>
<td>136–150</td>
<td>141</td>
</tr>
<tr>
<td>Potassium (K) (mEq/l)</td>
<td>3.4–5.0</td>
<td>4</td>
</tr>
<tr>
<td>Calcium (Ca) (mg/dl)</td>
<td>8.4–11.0</td>
<td>9.3</td>
</tr>
<tr>
<td>Inorganic phosphorus (IP) (mg/dl)</td>
<td>2.4–4.3</td>
<td>5</td>
</tr>
<tr>
<td>Growth hormone (GH) (ng/ml)</td>
<td>0.66–3.68</td>
<td>20</td>
</tr>
<tr>
<td>Thyroid stimulating hormone (TSH) (μU/ml)</td>
<td>0.34–3.5</td>
<td>1.3</td>
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<tr>
<td>Parathyroid hormone (PTH) (pg/ml)</td>
<td>160–520</td>
<td>470</td>
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<tr>
<td>Aldosterone (pg/ml)</td>
<td>35.7–240</td>
<td>79</td>
</tr>
<tr>
<td>Vitamin A (IU/dl)</td>
<td>65–276</td>
<td>138</td>
</tr>
<tr>
<td>Vitamin D (ng/ml)</td>
<td>10–55</td>
<td>26</td>
</tr>
</tbody>
</table>

Fig. 4  Comparison of the PCR product size of the AMGX from the AI patient and a normal individual

P: Amelogenesis imperfecta patient  N: Normal individual
M.W.: Molecular weight (bp)
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Gene of the patient does not contain a deletion, a base substitution, nor a mutation in the DNA splicing donor and acceptor sites of introns or in the promoter region involved in the gene expression of the amelogenin gene.

DISCUSSION

Enamel hypoplasia is considered to be due to local or systemic disturbances in the developmental enamel\(^9\). Local factors causing enamel defects include trauma, inflammation, tumors of the jaws, and radiation hazards. The present patient had no history of exposure to radiation or traumatic disease, and no osteomyelitis or tumor of the jaw. Since enamel defects were present in both the deciduous and all permanent teeth, traumatic injury, apical periodontitis of the deciduous teeth, and inflammation were ruled out as causes. Systemic factors causing enamel defects include a variety of conditions:

1. Nutritional deficiencies
5. Genetic disorders: amelogenesis imperfecta, epidermolysis bullosa hereditaria, pseudohypoparathyroidism, trichodentoosseous syndrome, ameloonychohypohidrotic syndrome, trichoonychodental syndrome, tuberous sclerosis, morquio syndrome, oculodentodigital dysplasia.
6. Avitaminosis D and hypervitaminosis D.
8. Endocrinopathies: hypothyroidism.

We suspected that the cause was a systemic factor and examined the general conditions of both mother and patient during the gestational period, her conditions at birth, her postnatal development and nutritional state, her history of previous diseases and drug use, pedigree, X-ray photographs, and the biochemistry of her blood serum, but there was no evidence suggesting a disturbance of amelogenesis. Because there were no morphological and biochemical abnormalities other than the protopathic disturbances of the enamel of both the deciduous and permanent teeth, a mutation of the amelogenin gene related to enamel formation was suggested.

Lagerström et al.\(^2\text{–}^4\) reported that, in patients with X-linked amelogenesis imperfecta, there was a deletion of 5 kbp in the amelogenin gene extending from exon 3 through exon 6. The enamel showed hypocalcification. In males, the enamel of patients was softer than that of normal subjects. In females, normal and abnormal enamel strips were alternately arranged. Lagerström et al.\(^5\) reported a case with a deletion of nine bases in exon 2 of the amelogenin gene. In this case, the enamel was thinner than that of normal teeth, and its surface was smooth. Aldred et al.\(^6\) and Lench et al.\(^6\text{–}^8\) reported cases with a deletion of one base in exon 5 of amelogenin gene who showed a mixture of enamel hypoplasia and enamel hypocalcification. We also reported a case with a deletion of one base in exon 2 of the amelogenin gene. In our case, the enamel was thinner than that of normal teeth, and its surface was smooth and hard\(^1\). These previous reports altogether suggest that mutations in the amelogenin gene contribute to amelogenesis imperfecta. In the present case, we suspected a mutation in the amelogenin gene and performed nucleotide sequencing of exons of the amelogenin gene, but we could not find any evidence of mutation. We suggest that a mutation of the some gene related to enamel formation or the adventitious factors contributed to the
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REFERENCES


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