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METABOLIC DISORDERS AS A FACTOR IN PATHOLOGICAL CHANGES OF DENTAL HARD TISSUES DURING TOOTH DEVELOPMENT

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Abstract

The formation of dental hard tissues is a metabolically dependent process closely related to the general health status of the organism during prenatal and early postnatal development. Disturbances in mineral metabolism, deficiencies of vitamins and trace elements, as well as endocrine disorders may significantly affect the processes of amelogenesis and dentinogenesis. This narrative review summarizes current evidence on the role of metabolic factors in the development of pathological changes in enamel and dentin, discusses pathogenetic mechanisms, and highlights their clinical relevance for dental practice.

Keywords: Metabolic disorders, amelogenesis, dentinogenesis, enamel hypoplasia, dentistry.

Introduction

Pathological changes in dental hard tissues arising during tooth development represent an important interdisciplinary issue at the intersection of dentistry, pediatrics, and endocrinology. Unlike hereditary forms of enamel and dentin defects, metabolically induced alterations are acquired in nature and are often

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associated with maternal health during pregnancy or the child's systemic condition in early life.

Mineralization of dental hard tissues requires a precise balance of calcium, phosphorus, magnesium, and adequate intake of vitamins, particularly vitamin D. Any disruption in these processes may lead to enamel hypoplasia, delayed mineralization, and increased susceptibility of teeth to dental caries.

The aim of this review is to analyze current scientific concepts regarding the influence of metabolic disorders on the development of pathological changes in dental hard tissues during tooth formation.

The Role of Mineral Metabolism in Dental Hard Tissue Formation

Mineral metabolism plays a key role in ensuring proper mineralization of enamel and dentin. Hydroxyapatite, the principal structural component of dental hard tissues, is formed through tightly regulated calcium and phosphate homeostasis. Hypocalcemia resulting from malabsorption, vitamin D deficiency, or parathyroid gland dysfunction leads to insufficient enamel mineralization. Clinically, this manifests as focal or generalized enamel hypoplasia characterized by thinning of the enamel layer and surface defects.

Impact of Vitamin Deficiencies

Vitamin D

Vitamin D plays a central role in the regulation of calcium–phosphate metabolism. Its deficiency during tooth development, particularly in early childhood, is associated with rachitic changes affecting both bone tissue and dental hard tissues.

Vitamin D deficiency results in impaired enamel mineralization, delayed tooth eruption, and the formation of structurally compromised dental hard tissues.

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Vitamins A and C

Vitamin A is involved in the regulation of epithelial cell differentiation, including ameloblasts. Its deficiency may disrupt enamel matrix formation. Vitamin C is essential for collagen synthesis, a major component of the organic dentin matrix. Insufficient vitamin C intake leads to impaired dentin structure and reduced mechanical strength.

Endocrine Disorders and Dental Hard Tissue Pathology

The endocrine system significantly influences growth and development processes, including odontogenesis. Thyroid disorders, particularly hypothyroidism, can delay mineralization and result in impaired formation of dental hard tissues.

Diabetes mellitus, especially when poorly controlled during childhood, may alter microcirculation and metabolic processes, negatively affecting enamel and dentin formation.

Perinatal Factors and Their Significance

Maternal metabolic disorders during pregnancy, such as gestational diabetes, anemia, and micronutrient deficiencies, directly influence tooth germ development in the fetus. Inadequate nutrient supply may result in enamel defects that become clinically evident only after tooth eruption.

Studies indicate that preterm infants and children with low birth weight have a higher risk of enamel hypoplasia, emphasizing the importance of intrauterine factors in dental hard tissue development.

Clinical Manifestations and Dental Significance

Metabolically induced changes in dental hard tissues, present with diverse clinical manifestations. The most common findings include enamel hypoplasia,

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discoloration, increased tooth sensitivity, and a heightened risk of rapid caries progression.

Early identification of these conditions is essential for implementing preventive strategies aimed at strengthening dental hard tissues and reducing the risk of complications.

Prevention and Future Perspectives

Prevention of metabolically related dental hard tissue disorders should begin at the stage of pregnancy planning and include nutritional optimization, adequate intake of vitamins and minerals, and management of endocrine diseases.

Current research focuses on identifying biochemical markers that may help predict the risk of mineralization disturbances and enable timely preventive interventions.

Conclusion

Metabolic disorders constitute a major etiological factor in the development of pathological changes in dental hard tissues during tooth formation. Mineral and vitamin deficiencies, endocrine diseases, and perinatal factors exert a complex influence on amelogenesis and dentinogenesis. A comprehensive interdisciplinary approach to diagnosis and prevention may reduce the prevalence of dental hard tissue defects and improve overall oral health outcomes.

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