TPM Vol. 32, No. S5, 2025
ISSN: 1972-6325
https://www.tpmap.org/

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THE GENETIC BLUEPRINT OF SMILES: UNRAVELING THE LINK BETWEEN DNA AND ORAL HEALTH

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Abstract: Genetics, the branch of biology that focuses on genes and inheritance, is essential in understanding the development of numerous disorders in the body. When it comes to oral health, genetic influences can result in developmental problems, precancerous conditions, and cancers. This review explores how genetic disorders affect oral health and highlights the opportunities for early intervention.

Keywords: Genes, Health, Oral Health, Dental Disorders, Genetics, Mutation, Dentistry

INTRODUCTION

Genetics examines how biological inheritance is transmitted and its effects. This encompasses the study of genes on both molecular and population scales. Genetic mutations can be categorised into two types: hereditary mutations, which are passed down from a parent and found in every cell, and acquired mutations, which arise from environmental factors and affect specific cells. The importance of genetics in dental diseases and abnormalities has received growing interest. This article explores different dental anomalies and their genetic foundations. [1,2]

Genetic Disorders Affecting Orofacial Structures:[3,4]

Disorders of Jaw and Facial Structures

- Cherubism
- Cleidocranial Dysplasia
- Gardner Syndrome
- Mandibulofacial Dysostosis
- Nevoid Basal Cell Carcinoma Syndrome
- Osteogenesis Imperfecta
- Apert Syndrome
- Crouzon Syndrome

Disorders of Oral Mucosa

- Hereditary Hemorrhagic Telangiectasia
- Multiple Endocrine Neoplasia Syndrome IIB
- Neurofibromatosis
- Peutz-Jeghers Syndrome

- White Sponge Nevus

Disorders of Enamel

- Amelogenesis Imperfecta
- Hypoplastic Forms
- Autosomal Dominant and Recessive Hypoplasia
- Hypocalcified and Hypomaturation Forms
- Snow-Capped Teeth
- Enamel Disorders Linked to Systemic Diseases and Genetic Syndromes

Disorders of Dentin

- Taurodontism
- Thistle-Shaped Pulp Chambers and Shell Teeth
- Dentin Dysplasia (Coronal and Radicular Forms)
- Hereditary Opalescent Dentin
- Dens Evaginatus and Dens in Dente
- Generalized Genetic Disorders such as Globodontia and Tricho-Dento-Osseous Syndrome

Miscellaneous Genetic Disorders

- Pseudohypoparathyroidism
- Idiopathic Hypoparathyroidism
- Fabry's Disease
- Scleroderma
- Progeria
- Erythroblastosis Fetalis

Genetics and Dental Anomalies:[5,6]

Dental Caries: The formation of dental caries is affected by both genetic and environmental elements, including salivary flow and immune system traits. Recent advancements in genetic engineering have resulted in the development of transgenic strains of S. mutans that do not possess genes associated with tooth decay.

Craniofacial Defects Linked to Genetic Mutations:[7]

Genetic Syndromes and Their Associated Genes

1. ***Apert Syndrome***
   - Gene: FGFR-2
   - Location: Chromosome 10q25-q26
2. ***Treacher Collins Syndrome***
   - Gene: TCOF-1
   - Location: Chromosome 5q32-q33.1
3. ***Marfan Syndrome***
   - Gene: FBN1
   - Location: Chromosome 15
4. ***Vander Woude Syndrome***
   - Gene: IRF-6
   - Location: Chromosome 1q32, 17p11
5. ***Crouzon Syndrome***
   - Genes: FGFR-2, FGFR-3
6. ***Tricho-Dento-Osseous Syndrome***
   - Location: Chromosome 17q21.3-q22
7. ***McCune-Albright Syndrome***
   - Gene: GS alpha
8. ***Turner Syndrome***
   - Karyotype: 45 (X0)
9. ***Patau Syndrome***
   - Condition: Trisomy 13

Periodontitis: Genetic predisposition is a key factor in the development of periodontitis, influenced by the interplay between genetic and environmental elements. Changes in the IL-1 gene are frequently linked to both chronic and aggressive types of the disease. [8]

Malocclusion: Genetic factors play a vital role in shaping dental occlusion and malocclusion, emphasizing the impact of heredity on dental development. [9]

Oral Cancer: The occurrence of oral cancer is significantly greater in individuals who smoke heavily or drink alcohol. Genetic mutations, especially in oncogenes and tumor suppressor genes, play a key role in the development of oral cancer. [10]

Role of Genetics in Structural Anomalies:

Enamel Disorders: Enamel disorders like Amelogenesis Imperfecta can be inherited through different patterns, including X-linked, autosomal dominant, and autosomal recessive inheritance. Several important genes play a role in these conditions.[11]

Dentin Disorders: Dentinogenesis Imperfecta is marked by different variations linked to genetic mutations, with certain types also related to osteogenesis imperfecta**.** [12,13]

Recent Advances:

- **Dental Genetic Testing:** Genetic testing is now feasible using saliva or cheek swabs for various purposes.[14]
- **DNA Vaccination:** Plasmid DNA is used to induce protein expression within cells[15].
- **Biochips:** DNA chips facilitate drug discovery and pharmacogenomic research.[16]
- **Human Cloning:** Techniques involve creating genetically modified organisms for medical purposes.[17]
- **Recombinant DNA Technology:** This technology supports gene therapy and the development of transgenic organisms and drugs.[18]
- **Metabolomics:** Focuses on the quantitative analysis of metabolites in biological samples.[19]

CONCLUSION

Dentists are essential in recognizing and addressing oral health concerns. A comprehensive understanding of genetics and molecular biology can significantly enhance the treatment of oral diseases and improve overall healthcare delivery. By integrating genetic insights into their practice, dentists can tailor treatments to individual patients, predict disease risk, and implement preventive measures more effectively. As research continues to evolve, the collaboration between dental professionals and geneticists will be crucial in advancing oral health outcomes and ensuring a holistic approach to patient care. Embracing these advancements will not only enrich dental practices but also pave the way for innovative strategies in managing oral diseases in the future.[20,21]