The Enigma of Genetics on Development of Human Dentition

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Abstract

Influence of genetics and environmental factors in the etiology of malocclusion has been a matter of debate in Orthodontic literature. Both genetic and environmental factors interact to develop the phenotype of an individual (nature and nurture). A sound knowledge of various etiologies of malocclusion is an essential pre requisite; also considering a genetic basis for occlusal variations is a major focus of interest for an orthodontist. Contemporary clinical opinion emphasizes the role of heredity as a major cause of malocclusion. The key to determination of etiology of malocclusion and its treatability lies in the ability to differentiate the effect of genes and environment on the development of craniofacial skeleton in a particular individual. It is well known that genetics as well as environmental play important roles in the etiology of various dentofacial and skeletal anomalies. Genetic mechanisms underlying development are particularly predominant during embryonic craniomorphogenesis. The process of tooth development is strictly regulated by various epithelial and mesenchymal factors. It is of great value in making preventive and interceptive orthodontic procedures so that malocclusions could be prevented or least intercepted by timely removal of the causative factor. Recent advances in genomic technologies and research offer exciting possibilities to reveal genetic basis for differences in orthodontic tooth movement between humans. Recent studies in genetic sciences allow the orthodontist to better understand the effect of genetics on the development of dentofacial characteristics, therefore formulate a treatment plan accordingly. The purpose of this article is to collect comprehensive data on various dentofacial anomalies associated with a genetic etiology, add genetic information in orthodontic literature on the interaction between genetics and orthodontics and review the application of genetic studies to the etiology of malocclusions.

Keywords: Gene; Allele; Malocclusion; Dental anomalies; Craniofacial growth; Mutation; Genetic polymorphism

Introduction

Growth is the combined result of interaction between genetic and environmental factors over time. Also malocclusion is a manifestation of interaction between genetic and environmental factors over time on the development of orofacial region. It is important to consider genetic factors in orthodontic diagnosis in order to understand the causative factors of malocclusions which have an overall influence on the final outcome of orthodontic therapy [1]. The genetic profile of an individual influences his reaction to environmental challenges including orthodontic forces therefore mechanotherapy. Malocclusions with genetic causes are generally less amenable to treatment than those with developmental causes. Greater the genetic component worse is the prognosis for patient for successful outcome by orthodontic intervention. Gene is a particular segment of DNA which is responsible for inheritance and expression of character. They are the structural units of heredity located on the chromosomes. Genome [2] is defined as the entire genetic content of a set of chromosomes present in a cell or an organism while genotype is the genetic constitution of an individual. Heredity refers to the transfer of characters or traits from parents to the offspring. Phenotype denotes the observable physical characteristics while trait is referred to as a characteristic of phenotype. Traits resulting from a complex interaction of genes are called polygenic traits. The nature of these traits can be studied by constructing family trees called pedigrees. The association of two or more traits together more often that would be expected is referred to as a syndrome.

Genetic mechanisms are mainly predominant during embryonic craniomorphogenesis. Various modes of inheritance include autosomal dominant, autosomal recessive, sex linked and...
Diagnosis of genetic disorders

When a specific allele occurs in >1% of the population, it is called as genetic polymorphism. Location of a particular gene or a nucleotide sequence on a chromosome is called locus. Mutations at a specific gene locus result in simple mono-genic diseases, syndromic condition or traits with Mendelian transmission (autosomal dominant or recessive, X-linked). Generally familial aggregation and twin studies identify condition with important genetic basis. Also familial aggregation studies involve identification of a given trait among family members. In these studies, differences between mother-child, father child and siblings are analyzed. Twin studies involving comparison between monozygous and dizygous twins are helpful in determining contribution of genetics versus environment to a given trait or disease.

Segregation analysis is also used to identify models of genetic transmission while linkage analysis is used to localize genes for a trait to a specific chromosomal location. Other approaches used to identify disease causing genes include association analysis, susceptibility profiles and medical sequencing.

Treatment options and methods

Examination of parents and older siblings gives information regarding treatment needs for the child and treatment can then be begun at an early age. Consideration of genetic factors is an essential element of diagnosis that underlies all dentofacial abnormalities. This part of diagnosis is important to understand the cause of the problem before attempting treatment. Knowing the relative influence of genetic and environmental factors would greatly enhance the clinician’s ability to treat malocclusions successfully.

Conclusion

How genetic factors influence response to environmental factors particularly treatment and long term stability should be the greatest concern for the clinician. Future studies should be aimed at determining the interaction of genes with each other which would help in improved genetic counseling and formulating public health policies. Till date, little study has been devoted to specific genetic factors that influence tooth movement. However recent advances in genomic technologies and research offer exciting possibilities to reveal genetic basis for differences in orthodontic tooth movement between humans.

References