Review Article

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Genetics & Orthodontics

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ABSTRACT

Background: The field of genetics emerged since 20th century. Since that time, genetics has progressed through a series of defined eras based on a number of major conceptual and technical advances. During the last two decades, significant advances in the field of genetics has proven to be beneficial in understanding the genomic basis of malocclusion and the gene variants associated with it. Over the period of time, genetic component has always been considered as one of the prime factors contributing to the nature and severity of malocclusion in the field of orthodontics. Malocclusion is a developmental problem. The origin of malocclusion can have great impact in deciding the treatment protocol for that particular patient. Orthodontists therefore has an inclination towards understanding the role of genetics contributing to nature and severity of malocclusion which can help them devise treatment plan accordingly.

Keywords: Genetics, Malocclusion.

INTRODUCTION

Malocclusion is a developmental problem. It is known that both hereditary and environmental factors have important influences on craniofacial development. However, one might not be able to determine whether the malocclusions are determined by the genetic code or environmental factors or a combination of both.[1]

The etiology for developing or developed malocclusion has been broadly categorized into:

A. Genetical Influences
B. Environmental Factors

Concept of genetic influences on malocclusion evolved since 20th century. During the last two decades, significant advancements in understanding the genetic basis of craniofacial development and gene variants associated with dentofacial deformities have resulted in convergence of principles and concepts in genetics and in orthodontics that will lead to significant advancement of orthodontic treatments.

Molecular Genetics

Genome

A genome is an organism's complete set of DNA, including all of its genes. Each genome contains all of the information needed to build and maintain that organism.

Gene

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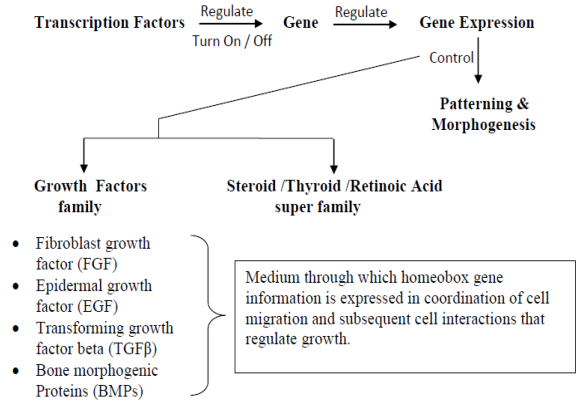

A gene is a locus (or region) of DNA that encodes a functional RNA or protein product, and is the molecular unit of heredity.

Genotype

A genotype is an individual's collection of genes.

Phenotype

A phenotype is an individual's observable traits, such as height, eye color, and blood type.

Proband

The proband is the first affected family member who seeks medical attention for a genetic disorder.[2,3]

Homeobox Genes

Homeobox genes are characterized by the possession of a particular DNA sequence, the homeobox, which encodes a recognizable although very variable protein domain, the homeodomain.[4] Homeobox gene related to craniofacial complex :

i. HOX group.
ii. Msx1 and Msx2 (muscle segment).
iii. Dlx (distalless).
iv. Otx (orthodontical).
v. Gsc (goosecoid).
vi. Shh (sonic hedgehog).

Proteins that are encoded by these homeobox genes are the transcription factors which control transcription of RNA from DNA template within cell nucleus.

Genetics and Environmental Interactions

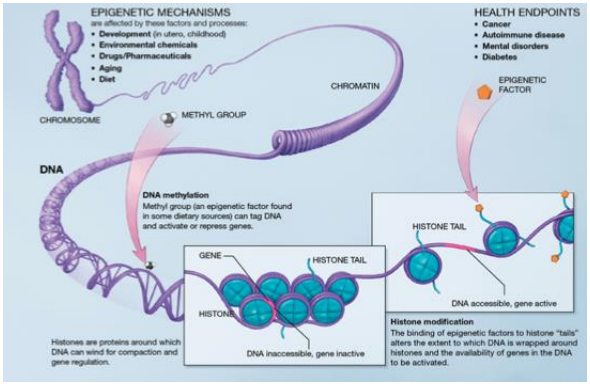

Fig 1: Genetic & Epigenetic Interactions.

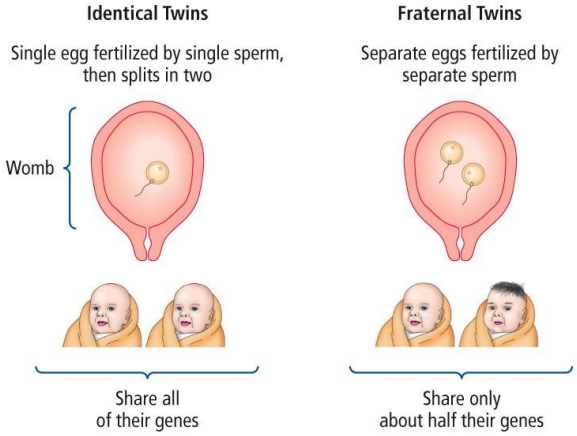

Fig 2: Genetic Morphology of Monozygotic & Dizygotic Twins.

Genetic Predisposition to Skeletal and Dental Anomalies

Stockard in 1941[6] concluded that individual features of the craniofacial complex could be inherited according to Mendelian principles independently of other portions of the skull, and that jaw size and tooth size could be inherited independently,and as genetically dominant traits.

Twin studies have shown that tooth crown dimensions are strongly determined by heredity (Osborne et al., 1958).[7] The molecular genetics of tooth morphogenesis with the homeostatic Hox 7 and Hox 8 (now referred to as MSX1 and MSX2) genes being responsible for stability in dental patterning (Mackenzie et al., 1992),[8] is confirmation of Butler's field theory (1963). This refers to primate tooth development in evolution with the stability of morphology, eruption pattern and tooth number in the incisor, canine, premolar, and molar domains.

Gruneberg[9] suggested that a tooth germ must reach a critical size during a particular stage of development or the structure will regress, and Suaraz and Spence[10] showed that hypodontia and reduction in tooth size are in fact controlled by the same or related gene loci. It is apparent from all the evidence in this respect that tooth size fits the polygenic multi-factorial threshold model.

Class II and III skeletal patterns have long been thought to have a genetic basis. The inheritance of the "Hapsburg jaw" (mandibular prognathism demonstrated by several generations of the Austro-Hungarian monarchy) is a classic example.

Along with a genetic influence there is also an environmental influence on the anteroposterior position of the maxilla and maxillary alveolar bone. Habits such as mouth breathing and digit sucking can cause an advancement of the maxillary alveolar process, whereas an anterior cross-bite relationship in Class III patients can hinder normal forward maxillary growth. The vertical position of the maxilla and maxillary alveolar process can also be influenced by environmental factors. Therefore these environmental factors may increase or decrease the inherited size and position of the maxilla in Class II and Class III patients. Mandibular growth is much less likely to be affected by environmental factors in the antero-posterior plane; however mouth breathing, tongue position and function can to some extent influence the mandible's vertical orientation.

CONCLUSION

Malocclusion has always been a multifactorial etiology with no one factor being responsible for it. Genetic and Environmental interactions has made impossible for a clinician to distinguish the etiology of malocclusion separately. Hence in order to treat malocclusion both these factors have to be accounted for and taken into consideration before planning the treatment modality/modalities. Certain genes, being responsible for the cause of malocclusion, can be prevented from being prevalent into the society through genetic counseling. The clinician will be more aware of, with the progress in the field of genetics, the unique genetic features of a malocclusion and will be able to devise better treatment plans customized for each individual according to his/her needs, responses and goals.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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