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REVIEW ARTICLE

GENODONTICS

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ABSTRACT

This review article will present the concrete educational, research strategies and a discussion of the genetics into the dental curriculum. Dentists are now entering the era in which genetics and genomics will play a vital role in both oral health research and dental practice. Dental professionals should understand the basic concept of genetics and genetic disorders that contribute to common dental concerns where more than 300 genes have so far been associated with tooth development is under strict genetic control.

INTRODUCTION

Genodontics is a term coined for the first time by K.Pandi Suba to implicate the importance of genetics in dentistry. The term can be applied herewith for all research studies, tests and diagnosis in the field of dentistry. Genodontics is a branch of dentistry that deals with the application of genetics to discuss the genetic factors and genetic tests which relates to the oral / dental diseases and oro-facial anomalies.

Uses

- For analysis of susceptibility factor.
- To understand the impact of genetics factor on oral health condition.
- In preventive treatment strategies.
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Genetics and dental professionals

The contribution of hereditary factors to caries, periodontal disease, oral cancer, absent or malformed teeth, and other common oral disorders is becoming increasingly evident in dentistry, and are considered as the implications of systematic genetic disease on oral health care. Dentists must be able to recognize indications of a hereditary component involved in oral pathology. The dental professionals need to anticipate the application of genetic information in a proper way that is ethical or detrimental to an individual or groups of people. A good genodontist requires a basic understanding of the genetics of oro-dental diseases, knowledge of the types of genetic testing available. Advancement in genomics aids the dentists to understand, recognize, and utilize genetics commensurately.

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Dental professionals must realize that every individual vary in their genetic predisposition and response to oral pathogens and other environmental factors.

Attitudes in genodontics

Genetics contributes to all diseases, including dental disease. Dental professionals need to appreciate the emerging uses of genetics in prevention, diagnosis, and treatment of dental conditions as well as theirs limitations. Currently, genetic testing is becoming more widely accepted; however, it is often conducted without focused diagnostic goals. It is due to

a) Genetic information may have treatment implications not only for an individual patient, but also for a family and, in some cases, for an entire community.
b) The potentially disconcerting nature of genetic information, particularly as it relates to interpretation of predictive tests.

Genodontics in dental education

Human genetics and dentistry will continue to have an impact on each other so that dentistry will meet the challenge with innovative educational programs, advances in dental research, and more importantly, interdisciplinary diagnostic and therapeutic concepts (Shuler CF., 2001). Genetics and its implications in dental education have already been analyzed earlier. The fundamental knowledge to be acquired by the dentists includes,

a) Genetic transmission mechanisms
b) Human genomic biology in molecular level
c) Population genetics frequency protocols.

Dental graduates must also be skilled to demonstrate,

a) The family background of the patient
b) To identify head & neck genetic disorders
c) Genetic diagnosis, testing & treatment

Genetics can be included in dental education through a spiral curriculum model that begins with platform knowledge courses proceeding to discipline based and integration courses with individual experiences. With this basic curriculum the genetic knowledge can be clinically applied and dental professionals can excel in Genodontics. This new entity can also educate the dentists in

- Simple considerations resulting from single gene defect.
- Complex considerations which result from a collection of altered genes interacting with environmental influences.

The above considerations can be dealt as follows:

1. **Simple hereditary conditions**

   Normal development and maintenance of the craniofacial complex is highly regulated at the molecular level. Odontogenesis can thus have simple gene disorders (Jones *et al.,* 1997).

2. Congenitally missing teeth: Hypodontia is the most common simple hereditary trait affecting oral cavity with maxillary lateral and premolar being most commonly involved excluding 3rd molars. Several genetic mutations resulting in Hypodontia have been identified.

3. **Complex hereditary Oral health condition**

   a) The two most common oral diseases that affect large segments of population are dental caries and periodontal disease.

   b) Heredity also appears to play a significant role in most common form of chronic periodontitis.

   c) Mutations in specific genes are responsible for various syndromic conditions in which periodontitis is one of the commonest feature such as, Papillion Lefere Syndrome, Haim Munk syndrome, and to some extent prepubertal periodontitis.

   d) Genetic studies of aggressive forms of periodontitis suggest that susceptibility is inherited by genetic trait, but it is not clear how many genes may be involved in these non-syndrome forms of periodontitis.

Genetics and genomics will play a vital role in both oral health research and dental practice. Dentists have long recognized patients that have a genetic contribution to a dental health problem such as physical malformations resulting from a hereditary condition, abnormal tooth formation, periodontal disease, etc. Other patients may also have oral complications resulting from undiagnosed systemic health problems where genetic factors play an important role in causing, oral diseases such as adult-onset diabetes.

Application of genodontics in dentistry

Dentistry can apply Genetic Engineering to enable the necessary modification in a specific target genome and thus aiding the synthesis of new substances or to perform new functions. For e.g. Teeth that are lost due to extensive caries, periodontal disease or accidents could be replaced with new, genetically created ones. Thereby, a person could have real, natural teeth either re-implanted or re-grown in place of the missing ones (Rosen *et al.,* 1961), which can be an alternative to partial denture or implants.

Pharmacogenomics an emerging discipline that measures the genetic characteristics of dental patients that influence the dental care such as response to medications. This can be applied to analyze the patient's response to alternative medications such as herbal therapeutics in oral cancer etc., which can also be useful in refractory conditions (Francis Collins *et al.,* 2004).

Proteomics is one of the most exciting research frontiers in modern dentistry. The two primary areas in which dental proteomics were useful are 1. Salivary diagnostics (also known as oral fluids diagnostics or oral fluid biomarkers) 2. Proteomics of bone and mineral structures, especially dental enamel. E.g. Proteomics is well applied in dentistry in observing the initiation of enamel crystals at the dentino-enamel junction which is associated with the expression of Dentin Sialophosphoprotein (DSPP, a gene normally linked with dentin formation), three 'structural' enamel proteins--amelogenin (AMELX), enamelin (ENAM), and ameloblastin (AMBN)--and a matrix metalloproteinase, enamelysin (MMP20) (Simmer *et al.,* 2001) . It is also used,

a) To study the dental phenotypes of the matrix genes to catalyze the formation of enamel crystals.
b) To characterize post translational modifications of enamel matrix protein.
c) To identify specific mutations in the genes encoding matrix proteins with a range of dental phenotypes.

Gene Therapy is a technique used for correcting genetic disorders. Gene therapy is applied

a) In the repair of osseous defects & can act on genes to regenerate bone as well as in cell repair useful in periodontal and oral surgical applications (MC Carn *et al.,* 2000) (Greenstein *et al.,* 2002).
b) Gene transfer mechanisms to salivary glands and Gene transfer to keratinocytes
c) For classical vaccination against dental caries and periodontal disease
d) For treating local tissue disorders and as a systemic gene therapeutic regimen.
e) To understand the general strategy to express a gene product that will result in cancer cell death.
f) To manipulate specific localized biochemical pathways involved in pain generation.

Limitations of gene therapy

1. Overzealous representation of medical gene therapy.
2. Overzealous, uncritical reports of clinical results are used by industry to promote investment and perceived dominance.
3. Ethical, legal and social issues are possible.

4. Genetic testing creates situation where there is little precedent and no appropriate gold standard to compare results.
5. Confidentiality takes an added dimension to assess health care and employment.

Genetic information is not fundamentally different from other health information except that genes cannot typically be changed and hence can impart a determinate aspect of health.

Forensic dentistry

The established importance of Forensic Dentistry for human identification is mainly when there is little remaining material to perform such identification (e.g. in fires, explosions, decomposing bodies or skeletonized bodies), which had led dentists in working with forensic investigation to become more familiar with the new molecular biology technologies. E.g. The identification of a person from epithelial cells on tooth brush. The teeth play an important role in the criminology, due to the high uniqueness of dental characteristics in addition to the relatively high degree of physical and chemical resistance of the dental structure. Due to their capacity of enduring environmental changes, the teeth represent an excellent source of DNA because this biological material may provide the necessary relation for identification of an individual in case of failure of conventional methods for dental identification. The results obtained from DNA extracted from the dental pulp did not show any difference when compared to the patterns obtained from DNA isolated from blood samples or other tissues (Sweet et al.,2000) (Silva et al.,2006).

Possible Applications of DNA in Forensic Dentistry

The environmental influence on the concentration, integrity and recovery of DNA extracted from dental pulps has been previously measured by varying the pH temperature, etc. It was determined that the environmental conditions examined did not affect the ability to obtain high-molecular-weight human DNA from dental pulp. In cases of physical assault, such as sexual abuse, murders and child abuse, bite marks are frequently found.

Genetic Testing

Genetic Dental Tests can help us to know the problems earlier and deliver more personalized treatment, which can greatly improve patient outcomes. Certain genetic mutations cause an autoimmune response from bacteria, which leads to inflammation and tissue damage. As technological progress makes genetic testing and screening readily available, treating physicians and dentists will obtain, use, store and maintain comprehensive and personal genetic information. (Hart and Ferrell, 2002).

Genetic variance

Genetic variance is the result of several factors, leading to the evolution of a species. It is influenced by several main criteria, including genetic mutation, the genetic elimination of recessive characteristics and addition of dominant ones, and the size of the available gene pool. Genetic variance can cause differences at an observable or phenotypic level in species, leading to explanations for things such as blood type, skin color and size (Osborne *et al.,* 1958).

Genetic variance is what allows for species adaptation over time. Whether through gene combinations in offspring or mutation, strong survival traits will tend to grow more dominant in a population. Alterations at the phenotype levels of physical traits, inherited behavior, or other observable characteristics can have an enormous affect on how a species survives in its environment. The wider the gene pool, the more successful the population, as genetic variance will weed out the poor survival traits and give dominance to the most successful. E.g. Comparative genetic variance and heritability of dental occlusal variables are noticed in twins. (Potter *et al.,* 1981)

Genetic Disorders in Dentistry

Genetic disorders in dentistry is divided into

- Bone
  - Acroosteolysis with osteoporosis and changes in skull and mandible.
  - Cleft lip / cleft palate - Dental anomalies
- Tooth
  - Adult syndrome
  - Amelogenesis imperfecta
  - Dentinogenesis Imperfecta
  - Extrinsic and Intrinsic Enamel Coloration.
  - Dental transposition
  - Dentin dysplasia, type I
  - Oligodontia-colorectal cancer syndrome
- Gingiva
  - Fibromatosis, gingival

Genodontics-future challenge to the dentists!!!

Dentists have a great responsibility to integrate genetic information into their clinical practice as it becomes available. This is a challenge because most practicing oral health professionals have had little exposure to genetics in their training. Due to constant & rapid changes in genetics the professionals need a foundation of knowledge about genetic principles and must have the ability to apply these principles to patient care and in interactions with other health care professionals who are part of a patient's health care team. "Foundation knowledge" includes knowing the structure and function of the genome in the cell and applying genetic information to patient care. Advancing knowledge in genomic science can contribute for future genetic discoveries to improve oral health. Acquiring these skills will require the technical retraining of practicing dentists, and an entirely new dental specialist—such as dental biogeneticist or dental genetic therapist—could emerge. As the ability to genetically alter the dental structures to resist dental disease increases, coupled with the capacity to mitigate the biological effects of oral etiological agents, dentistry as it is currently practiced could cease to exist. As a result, therapy will be gene-based and genetically developed drugs will target, and be effective for, most dental diseases. Armed with this knowledge, dentists will be able to understand and adjust chromosomal function to create optimal cellular performance. Dentistry will be affected profoundly, as current materials and methods are abandoned in favor of emerging bioengineered technologies for disease prevention, tissue repair and disease resistance. However,

despite the far-reaching potential of gene-based therapy, implementation is replete with ethical, legal and moral difficulties that society in general and the dental profession in particular must address as. The dental profession faces the challenge of addressing and resolving these concerns (Wright *et al.,* 2002).

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