AN OUTLINE OF ROLE OF DIFFERENT AETIOLOGICAL FACTORS IN HYPODONTIA- A REVIEW

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Abstract

Hypodontia or tooth agenesis is a developmental defect that affects a significant percentage of population. It is a multifactorial dental anomaly and involves genetic, environmental and evolutionary causes. Efforts and researches towards insight of the condition are important from the clinical and preventive aspects. Aim of the present review is to discuss the aetiological variations of common hypodontia cases.

Key Words Hypodontia, developmental, agenesis, genetic, dental anomaly.

INTRODUCTION

Hypodontia refers to the developmental failure of six or fewer teeth[1].Its phenotypic presentation is varied in terms of severity and as a result, various terms have been used to describe it.These terms include "congenitally missing teeth", "tooth agenesis", "hypodontia", "oligodontia", and "anodontia"[2]. The commonly used term "congenitally"missing teeth is a misnomer as permanent teeth that are most frequently missing are not present at birth[3].Tooth agenesis is a more informative term because it also implies the underlying defect. Oligodontia and anodontia are used to descri-be more severe forms of tooth agenesis, typically the absence of more than six teeth and the entire dentition[3]respectively.Hypodontia is used to indicate a more complex entity, involving not only aberrations in number, size and shape of the teeth but also abnormalities in the overall rate of dental development and time of eruption[4,5].Tooth agenesis and hypod-ontia are the preferred terms in this work, with the latter term limited to missing teeth other than third molars.

The incidence for permanent tooth agenesis ranges from 1.6% to9.6% in the ge-neral population excluding third molars[6,7-10].In the primary dentition, tooth agenesis is r-eported to be 0.5% to 0.9%[11-13].An interesting correlation on the number of missing tee-th and the tooth class has been made by Muller et al,[13] based on a collection of 14,940 adolescents. They have noted that maxillary lateral incisors are the most frequently missing teeth when only 1 or 2 teeth are absent, whereas second premolars are the most frequently missing teeth when more than 2 teeth are absent. Agenodontia and ablastodontia are the t-erms used when the missing teeth are, respectively, in deciduous dentition or permanent dentition.

Aetiology : The multiplicity of tooth agenesis theories suggests a multifactorial aetiology that involves genetic regulation and environmental factors. Dental development is a complex pro-cess which involves mutual interactions between the oral epithelium and ectomesenchyme derived from the neural crest cells[14]. A series of geneticaliy controlled successive molecu-lar interactions are involved in the development of teeth[15,16].Numerous factors, such as those from the fribroblast growth factor (Fgf), wingless related integration site (Wnt),bone m-orphogenic protein(Bmp), and hedgehog (Hh) families, take part in the signaling of the epithelialmesenchymal interactions in the tooth development[17]. Alterations in one or more of the signaling pathways may affect dental development and may play a role in causing a condition such as hypodontia.

Other theories focused on an anatomical principle, based on the hypothesis th-at specific areas of the dental lamina are prone to environmental effects throughout tooth maturation[16]. In support of this hypothesis, Svinhufvud

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et al.(1988) related the agenesis of the maxillary lateral incisors, the mandibular second premolars, and central incisors to the fact that they develop in areas of initial fusion of the jaw[18]. Instead, Kjaer et al.(1994) arg-ued that the region where development of innervation is last is the most sensitive one[19].

Craniofacial bones, cartilage, nerves and connective tissue all originate from n-eural crest cells. Specific developmental cascades are therefore common to the morphogenesis of both teeth and some craniofacial structures[20].Environmental factors such as trauma, infection, and toxins have long been known to be associated with a higher risk of some of the craniofacial anomalies[21].

Several studies have suggested that intrauterine conditions could be involve-d in the aetiology of hypodontia, such as with thalidomide. It was reported that hypodontia was more common in children with thalidomide embryopathy (7.7%) than in normal children (0.4%)[21,22].

Chemotherapy and radiotherapy treatment in early infancy have also been im-plicated in the development of hypodontia[23,24]. According to some research, rubella infection during pregnancy can cause hypodontia in the developing child[25]. Trauma, such as f-racture of the alveolar process may also contribute to hypodontia, although evidence supp-orting this is weak in the literature.

Neural crest cells are extremely sensitive to high levels of oxidative stress that can arise due to both genetic and environmental factors. It is generally accepted that oxidative stress in the form of smoking, for example[27], plays a central role in the development of neural crest cells and the aetiology of craniofacial anomalies. Given the hypodontia shares similar molecular pathways with some craniofacial anomalies, it would be useful to investigate whether there is an association between environmental factors and hypodontia.

Tooth agenesis or hypodontia can be discussed in evolutionary aspect too. Dental anthropology has been an active area of research investigating the evolutionary aspects of tooth development. Teeth probably originated as dermal structures called "odontodes",which subsequently migrated into the mouth, where they became associated with b-ones[25].Teeth are vertebrate-specific and within vertebrates species-specific.Tooth shape varies with position in the jaws and is bilateral and symmetric. Teeth and teeth-bearing bones evolve together[26]. The reduction in tooth number is concomitant with the reduction in the size of the jaws in human evolution and is believed to be a continuing evolutionary trend.

Attempts were made to explain developmental defects of teeth with evolutionary and anatomic models such as Butler's field theory. Butler's theory(1939) attempts to explain why certain teeth fail to form more than others. According to this hypothesis,mam-malian dentition can be divided into 3 morphological fields corresponding to incisors, canines, and premolars/ molars. Within each field, one key tooth is presumed to be stable; flankinging teeth within the field become progressively unstable.

CONCLUSION

Since tooth development is under some degree of genetic control, recent efforts have focussed on identifying the specific genes that are involved in regulating tooth development. Among these genes, PAX9(Paired box gene 9),MSX1(Muscle segment homeobox 1), AXIN2(Axis inhibition protein 2) are the most frequently reported genes associated with nonsyndromic hypodontia[29, 30-33].PAX9 is a transcription factor expressed in the tooth mesenchyme during tooth morphogenesis and mutations in this gene have been associated with tooth agenesis. In connection with evaluation of anatomic cause of hypodontia scientis have explained the selectivity of tooth agenesis in terms of an anatomic rather than an evolutionary model. These researchers suggested that certain regions during tooth develop-ment(eg.areas of embryonic fusion) are more susceptible to epigenetic influences and hence agenesis. For example the most frequently missing or variably sized tooth in maxilla develops in the area of the embryonic fusion between the lateral maxillary and medial nasal pro-cesses. The proponents of evolutionary model hypothesized the teeth most often missing teeth were" vestigial organs" with little practical value for modern man. In the evolutionary process these teeth provide no selective advantage for the species and hence have been lost[29].

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