TOOTH AGENESIS: THE MOST COMMON DEVELOPMENTAL ANOMALY

Darko Pop Acev

darko-pop-acev@hotmail.com

International Balkan University, Faculty of Dental Medicine, N. Macedonia

Abstract. Tooth agenesis is a condition at which the patient is missing one or more teeth, due to their failure to develop. Missing teeth are one of the most common developmental anomalies.This condition is an aesthetic as well as functional deficiency. The prevalence of missing teeth depends on the ethiological factors, gender, race, geographic and demographic distribution. Most common congenital tooth absence is affecting the teeth that are last developed in each group (lateral incisors, second premolars, third molars).The aim of this study is to make a review of the literature about the prevalence, the conditions associated with tooth agenesis and possible factors that can cause this anomaly.

1. INTRODUCTION

The development and growth of the human being is strictly determinant process of organogenesis, morphogenesis and differentiation. Deviation from the normal process can lead to anomalies in the structure or function. These deviations, if present during the childbirth, as a result of an abnormal prenatal structural development are called congenital anomalies [1, 2].

These changes can present just an aesthetic defect and then they are considered as mild forms of anomalies. However in addition to the aesthetic defect, the anomaly can be more severe and might cause a functional problem, too. The mild forms of anomalies are more common with 15% prevalence among newborns, while the severe ones are rare with prevalence of 1-2% [3, 4].

The main goal of orthodontics is to ensure harmony between the jaws and the teeth. Any violation in this relationship leads to aesthetic and functional issues.

One of the reasons that lead to aesthetic and functional imbalance is tooth agenesis. Tooth agenesis is a condition where the patient misses one or more teeth due to the developmental absence of its germ [5].

Dentogenesis present a complex process in which a tooth formation occurs. This process is a result of the interaction between the embryonic cells during the intrauterine period. The tooth germ is composed of three parts: enamel organ, the dental papilla and the dental follicle. This process is regulated by different types of genes like: Msx2, Lef2, Shh, Bmp2, Fgf8, Fgf20, Wnt10a, Wnt10b и Edar [6].

There are four phases of the process of dentogenesis: initiation, morphogenesis, differentiation and eruption. During these stages a lot of epithelial-mesenchymal interactions occur among the cells and tissues that determinate the tooth formation. Improper interaction between these processes can lead to number of developmental anomalies and malformations of the tooth structures and even tooth agenesis.

Depending of the number of teeth that are missing, tooth agenesis can be divided in three groups. Hypodontia describes situation when up to 6 teeth are missing, not including the third molars. Oligodontia is when more than 6 teeth are missing and anodontia present a situation when there is no single tooth in the patients mouth as a result of developmental issue (Figure 1 and 2).

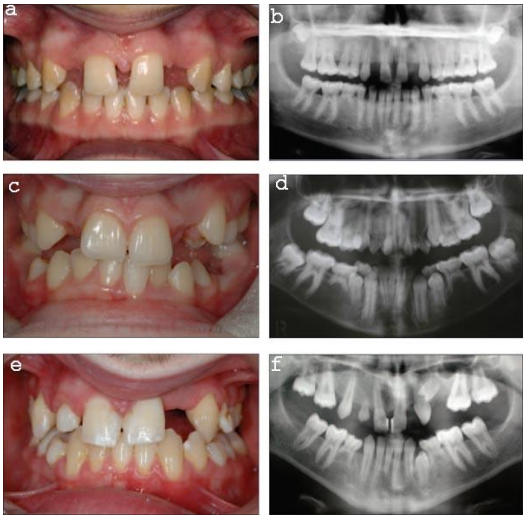

Figure 1. a), b) hypodontia on 12, 22, 35, 45
c), d) hypodontia on 15, 14, 24, 25, 35 45
e), f) oligodontia on 15, 14, 12, 22, 25, 31, 35, 44, 45
(http://www.nature.com/bdj/journal/v203/n4/images/bdj.2007.732-f1.jpg)

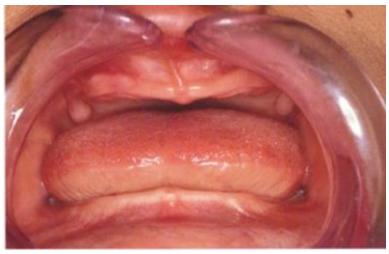

Figure 2. Anodontia (https://classconnection.s3.amazonaws.com/836/flashcards/489836/png/untitled1.png)

Some authors report different classification for hypodontia according to their severity. Most common one includes: mild with 1-2 congenitally missing teeth, moderate with 3-5 congenitally missing teeth and severe with 6 or more missing teeth [7, 8, 9].

Congenital absence of the teeth can be seen as an isolated phenomenon (non-syndromic) or as an associated symptom of a sindromic disease (syndromic hypodontia). Non-syndromic hypodontia can be familial or sporadic. Sporadic hypodontia is when the tooth agenesis is present as an isolated case of hypodontia in one family member, while familial hypodontia is when tooth agenesis is present among several members of the same family [10]. The presence of tooth agenesis among several members of the same family indicates the hereditary factor in this anomaly.

On the other hand the syndromic hypodontia points out that the formation of the teeth and formation of other organs is under control of the same molecular mechanisms. The agenesis of the teeth can be present in more than 60 syndromes like ectodermal dysplasia, Pierre-Robin syndrome, Van Der Woude syndrome, Crouzon syndrome, Schöpf-Schulz-Passarge syndrome, tricho-odonto-onycho-dermal dysplasia, orofacial digital syndrome and Downsyndrome [11, 12, 13]

2. LITERATURE REVIEW

Tooth agenesis is the most common congenital dento-facial anomaly [14, 15]. Hypodontia presents functional as well as aesthetic problem [16, 17]. Patients with tooth agenesis could have: difficulty in mastication, incorrect pronunciation, lower anterior face height and insufficient development of alveolar bone. Additionally it can be accompanied with: abnormalities in the size and shape of the teeth (microdontia or peg-shaped teeth), anomalies in roots of the teeth (dilaceration), late teeth eruption, ectopic canines or enamel hypoplasia [18, 19, 20].

According to Krezci et al. tooth agenesis on permanent teeth has negative impact on the sagittal growth of the jaw and is followed by an increased over-jet [21]. The agenesis of the permanent teeth leads to a decrease in anterior facial height and maxillary retrognathism [22, 23].

Very often microdontia can be found in patients with tooth agenesis. The review of the literature shows positive correlation between the number of missing teeth and the prevalence of microdontia [24, 25]. Microdontia has been reported in healthy patients without missing any permanent teeth, but with relatives who are already missing more permanent teeth [26]. Teeth that are most commonly affected are those located in the anterior segment [27, 28] (Figure 3).

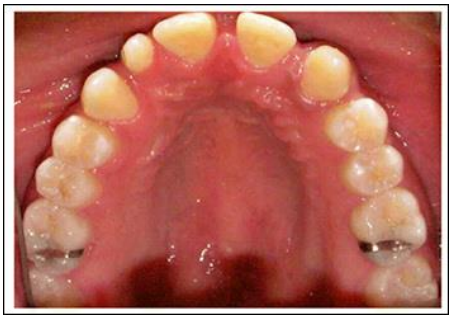

Figure 3. Tooth agenesis of the lateral incisor with microdontia of the contralateral incisor (http://egloos.zum.com/q8imcs/v/10726756)

The tooth agenesis can be associated with the changes in the shape of other teeth. Most commonly there is a change in the shape of the maxillary lateral incisor, when the contralateral is missing [29, 30]. Changes can be found in reduction of the number of cusps in premolars and molars or conical shape of the canines [31, 32].

An ectopic position of the permanent teeth can be also associated with the tooth agenesis. Some articles report that the risk for palatal positioned maxillary canine is six times higher in patients with an existence of another anomaly of the adjacent lateral incisor (tooth agenesis, microdontia, changes in the shape of the tooth) [33, 34]. The existence of a connection between these anomalies has also been noted among family members [35]. According to these reports, the palatal position of the maxillary canine is a consequence of local etiological factors influencing the lateral incisor, whose root has the role to guide the canine through its eruption.

Connection between these malformations and tooth agenesis indicates a common defect at the primary level.

Hypodontia in permanent dentition is one of the most common dentofacial anomalies with prevalence of 2,6-11,3% among different populations with third molars excluded from the study [36]. Teeth that are most commonly missing are those that develop last in their group like lateral incisors, second premolars and third molars [37]. The prevalence of the missing third molars is so common present in more than 25% of the population [38, 39]. That is why this condition is sometimes considered as normal.

Oligodontia and anodontia are rare conditions which usually occur as a symptom within a syndrome and rarely as an isolated case. The prevalence of oligodontia is between 0.08-0.16 with predomination in females [40]. Anodontia on

the other side is extremely rare condition, usually found as part of hypohidrotic ectodermal dysplasia. Its prevalence varies depending on gender, race, geographical and demographical distribution as well as ethnicity [41, 42].

Tooth agenesis can be found in the permanent as well as in the primary dentition. The prevalence of hypodontita in primary dentition is significantly lower with prevalence 0.08-1.55% [43]. There is a correlation between the tooth agenesis of the primary teeth with the permanent teeth. In most of the cases the tooth agenesis of the primary tooth is followed with a tooth agenesis of its permanent successor [43, 44]. The tooth agenesis in primary dentition is equally distributed between genders, with primary maxillary lateral incisors missing the most [45].

There is no significant difference between the affected sides, left or right, in permanent and in primary dentition. Also there is no significant difference between jaw distribution of the missing teeth in permanent dentition [46]. On the other hand there is significant difference between distribution of the missing teeth in both jaws in the primary dentition mostly due to the missing maxillary lateral incisor [47].

The cause for congenitally missing teeth remains fully unclear, although it is believed that this condition is correlated with the genetic factors as well as with the environmental factors that have impact during the developmental period, like the mothers age, the presence of systematic diseases, low weight of the newborn, virus infection during the fetal period, trauma and some drug exposition [48, 49, 50, 51, 52]. Smoking of mother can also be a possible risk factor for tooth agenesis [53].

According to some studies the most common missing teeth are those which get innervation last [54, 55].

Tooth agenesis often can be hereditary and also can be associated with certain genetic disorders, like ectodermal dysplasia and Down syndrome or to be a result of a hormonal imbalance (hypoparathyroidism).

Hypodontia is very common anomaly in patients with cleft lip and palate. Tooth that is most commonly affected is maxillary lateral incisor, followed by maxillary second premolar [56, 57]. The prevalence of tooth agenesis in these patients increases proportionally with the severity of the cleft [29]. Therefore the tooth agenesis is can be mostly seen in patients with bilateral cleft of the lip and palate and at least in patients with only cleft of the lip.

Hereditary factor is predominant factor for tooth agenesis compared to environmental factors. A lot of mutations have been detected in patients with tooth agenesis. These mutation can be inherited like autosomal dominant forms, autosomal recessive, X-linked or as a polygenic pattern. More genes have their impact in the process of inheritance. Mutations in these genes cause phenotypic changes, among others tooth agenesis. With these mutations there is an incorrect transcription of proteins that play role in dentofacial development.

A lot of studies have been made in order to find the exact genes that are responsible for this anomaly. Genes that are most commonly correlated with tooth agenesis are MSX1, PAX9, AXIN2, IRF6 and WNT10A [58, 59, 60, 61].

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