Evaluation of the prevalence of dental agenesis through the use of orthopantomography in a sample of subjects residing in Lombardy and Piedmont regions



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Abstract

Aim Dental agenesis is one of the most frequent dental anomalies, with a prevalence varying from 1.6% to 36.5%, depending on the populations studied. The patient's age at diagnosis, sex, and ethnic differences are considered possible influenting factors that can explain such a wide range of prevalence.

The objective of the study was to define the frequency of dental agenesis in a sample of subjects living in Piedmont and Lombardy regions of Italy.

Materials and methods Materials and methods: X-rays, already taken for other diagnostic purposes, were collected. Orthopantomographies belonging to subjects born after 1995 and aged between 7.9 and 16.9 years were selected. It was assessed the presence of each tooth, except for third molars since they are frequently absent due to their variability. If a tooth was missing and the patient had additional radiographs, the other radiographs were evaluated to confirm the diagnosis or to rule out a delayed calcification or the presence of a malposition tooth.

Results Orthopantomographies were collected from 1,020 subjects and 98 of them presented agenesis, with a prevalence of 5% for females and 4.61% for males. The most affected teeth were 35 and 45, followed by 12 and 22.

The lower arch was more frequently involved by agenesis: there were 107 teeth absent in the mandibular arch and 83 in the maxillary arch.

KEYWORDS dental agenesis, prevalence, orthopantomography

Introduction

Dental anomalies are alterations in the proper development of the teeth, and they can be classified into 5 different types and 16 subtypes: number, size (including microdontia and macrodontia), structure (including amelogenesis imperfecta, dentinogenesis imperfecta and dentinal dysplasia), position (including transposition, ectopia, displacement, impaction and inversion) and shape (including fusion-gemination, dilaceration and taurodontism) [Bilge NH et al., 2018].

Number anomalies are distinguished into hyperodontia, characterised by the presence of supernumerary teeth, and agenesis, characterised by the absence of one or more teeth due to failure to form the corresponding tooth germ. The latter is one of the most frequent dental anomalies; depending on the number of teeth affected, it can be divided into:

- Anodontia: the absence of the entire deciduous or permanent line.
- Oligodontia: the absence of more than half of the teeth of the deciduous or permanent series.
- Hypodontia: the absence of less than half of the teeth of the deciduous line or permanent occurs [Farronato G. et al., 2013].

Dental agenesis is rather rare and less common in the deciduous dentition than in the permanent one. However, there is an association between agenesis of deciduous and permanent teeth: agenesis of a deciduous tooth is often followed by an absence of the corresponding permanent one [Al-Ani AH et al., 2017].

The mean of agenesis in Europe is 4.6% for the male population and 6.3% for the female one; however, depending on the populations studied, the range varies from 1.6% to 36.5% [Al-Ani AH et al., 2017; Lebbe et al., 2017]. The patient's age at diagnosis, sex and ethnic differences are considered possible influential factors that can explain such a wide range of prevalence [Polder BJ et al., 2004]. In most cases, agenesis affects only one (48%) or two (35%) teeth. Furthermore, in the Caucasian population, the lower second premolars are most affected, followed by the upper lateral incisors, upper second premolars and lower central incisors [De Stefani A et al., 2020] (Figure 1). Regarding the deciduous dentition there is generally a greater involvement of the upper incisors [Nessi and Viganò L, 2004].

Subjects with agenesis usually have deeper spaces and bites, aggravating in the case of missing posterior teeth or extrusion of antagonistic teeth [Al-Ani AH et al., 2017]. Moreover, this issue can often be accompanied by other clinical situations, such as abnormality of shape or size (especially microdenture), ectopic or delayed eruption, prolonged retention, premature loss and infraocclusion of the deciduous tooth; all of these conditions lead

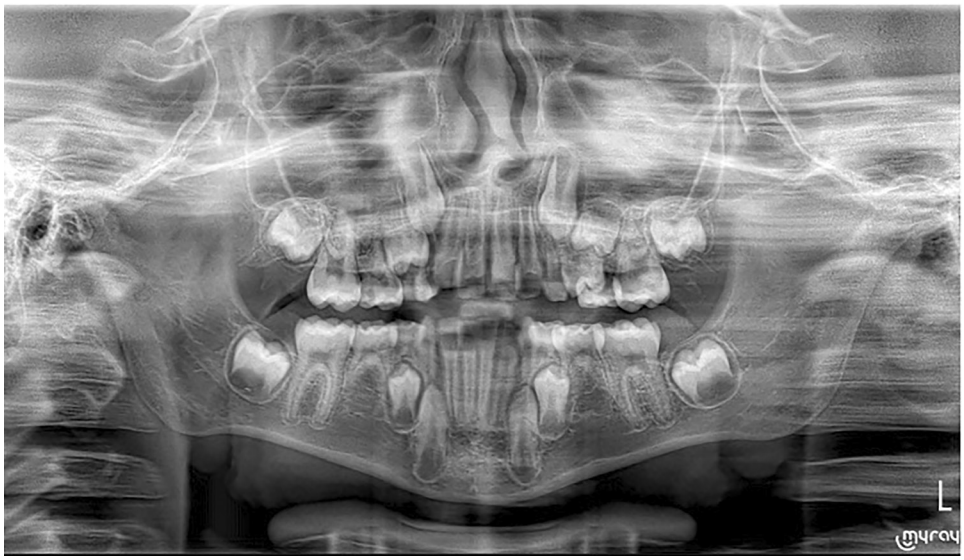


FIG. 1
Orthopantomography of a 9-year-old patient, who presents the absence of 35 and 45.

to malocclusion, as well as speech difficulties and aesthetic issues [Song, Shin et al. 2020].

Etiology

Over the years, different theories have been advanced to find the determining cause of the phenomenon of agenesis.

Early studies had focused on the theory of evolutionism, whereby as the intermaxillary complex, and consequently the dental arches, became shorter, the number of teeth was being reduced.

Nowadays, an interaction between genetics and environmental factors in the determination of dental agenesis is recognised [Al-Ani AH et al., 2017].

Genetic factors

Mutations in MSX1, PAX9, AXIN2, and EDA have been identified in case of non-syndromic hypodontia; on the other hand, mutations in Shh, Pitx2, Irf6, and p63 are associated with genetic syndromes [Song, Shin et al. 2020]. PAX9 is a transcription factor that is expressed in the mesenchyme of the tooth during morphogenesis; from its mutation a developmental arrest occurs during the budding phase. MSX1 is a gene expressed in condensing regions of the ectomesenchyma in the tooth germ and a mutation of which results in severe hypodontia in humans. The AXIN2 gene is involved in cell growth, proliferation and differentiation and has been associated with agenesis of the lower incisors [Al-Ani et al., 2017].

Environmental factors

Different environmental factors, intervening during odontogenesis, can lead to disruptions in normal dental development and consequently to agenesis. Infectious processes during pregnancy such as rubella virus, trauma to the alveolar process or jaw, jaw surgery, exposure to chemotherapeutic agents, radiation to the head or neck region and intake of thalidomide during pregnancy have been highlighted [De Santis D et al., 2019].

Classification of agenesis

Agenesis can occur either as an isolated (non-syndromic) condition or as a manifestation of a genetic syndrome. The non-syndromic form is the most common with general involvement of the secondary dentition. In the case of the syndromic one, more than 49 syndromes are associated with the absence of one or more teeth; among them the main ones are hypohidrotic ectodermal dysplasia, incontinentia pigmenti, Down syndrome, craniofacial dysostosis and syndromes associated with growth and developmental defects, such as cleft lip and palate [Gracco A et al., 2017]. Ectodermal dysplasia (prevalence: 1–9 / 100,000) and Down syndrome (prevalence: 1–5 / 10,000) occur most frequently [De Santis D et al., 2019].

Diagnosis

Identifying the lack of a tooth is very important not only for a correct orthodontic diagnosis, but also for the subsequent treatment planning [Lebbe A. et al. 2017]. Diagnosis of agenesis is carried out using panoramic radiographs, combined with clinical examination [Bilge NH et al. 2018]. During a dental visit it is possible to suspect agenesis when several clinical situations are present, such as the persistence in the arch of the deciduous tooth beyond its physiological exchange time and the presence of the contralateral already erupted, the persistence of an edentulous space, the absence of the deciduous tooth without a history of extractions or traumatic loss in that site or a positive anamnesis for family agenesis [Farronato G. et al., 2013]. Orthopantomography (OPG) provides a complete view of both dental arches and therefore it is the imaging exam indicated when dental agenesis is suspected; the diagnosis is performed when radiographically there is no sign of calcification of the crown and there is no history of tooth loss due to trauma, caries, periodontal or orthodontic treatment [Al-Abdallah et al. 2015].

A limitation of orthopantomography is the possibility of an unerupted tooth falling out of its pendulum plan, giving the impression that the tooth is absent [Nessi and Viganò L, 2004].

Treatment options

Therapeutic options in patients with agenesis are different and must be carefully evaluated with the patient to determine the best individual treatment.

Possible approaches are the maintenance of a space corresponding to the site of agenesis or its re-opening. In the latter case, the missing tooth is replaced with a prosthetic solution; the treatment plan should aim to best position the teeth already present in the arch and to obtain the correct spaces for prosthetic

rehabilitation. The advantage of this choice is maintenance of the integrity of the arch; each tooth is moved in its natural, correct position. There are disadvantages: fixed prosthetic replacement can only take place after the end of growth of the mandible, maxilla and alveolar processes, which occurs after 18 years of age. Until then, temporary prosthetic solutions, such as the a Maryland bridge, should be used to maintain space and provide adequate aesthetics.

A second solution is orthodontic closure of the space at the missing tooth and subsequent dental reshaping. This operative method has some disadvantages:

- Need to implement orthodontic therapy to establish clinically adequate occlusion; depending on the different clinical case, orthodontic therapy may be more complex.
- Need for dental reshaping to establish proper lateral and incisor guides.

The last option, when clinical conditions allow, is to try to keep the deciduous tooth in the arch as long as possible, under constant monitoring. The problem with this technique may be the sudden loss of the deciduous tooth [Farronato G. et al., 2013]. The frequency of patients with the permanence of a deciduous tooth varies from 0% to 9%. [Nordquist et al., 2005].

Due to the variable prevalence of this anomaly and the importance of the correct treatment planning, the objective of the following study was to define the frequency of dental agenesis in a sample of subjects living in Piedmont and Lombardy using panoramic radiographs.

Materials and methods

Radiographs used were collected from the databases of the Istituto Stomatologico Italiano in Milan and some private offices located in Piedmont and Lombardy regions of Italy.

Only X-rays previously taken for other diagnostic purposes were used, so that no subjects had to undergone to ionizing radiation for the purposes of the research. Subjects born after 1995, to avoid dated and low-quality X-rays, and between 7.9 and 16.9 years of age at the time of the radiographic examination.

The maximum age limit was set on the ground that with increasing age there may be more conditions that could lead to a false diagnosis, such as the possibility that the subject had undergone extractions not reported in the medical record.

The lower age limit was set taking into account that calcification of the crowns ends around 7 years; therefore radiographs of younger patients might lead to a false diagnosis of agenesis in cases of mineralisation not yet completed.

Presence of each tooth was assessed, except for third molars since they are often absent due to their variability [Wagner et al. 2020]. If a tooth was absent and the patient had other radiographs, the additional X-rays were also examined to confirm the diagnosis and to rule out delayed calcification or malposition.

Excluded from the study were:

- Radiographs of syndromic subjects.
- Low-quality radiographs.
- Radiographs that appeared to be doubtful and from which it was not possible to reach a definite diagnosis.

Results

Panoramic radiographs were collected from 1020 subjects, including 520 females and 500 males. For 851 subjects only one radiograph was evaluated, for 134 patients two, for 35 three orthopantomography, and for 7 four X-rays were examined.

Additional OPG were selected and examined in all cases in which a dental abnormality was found, and in those with a doubtful diagnosis.

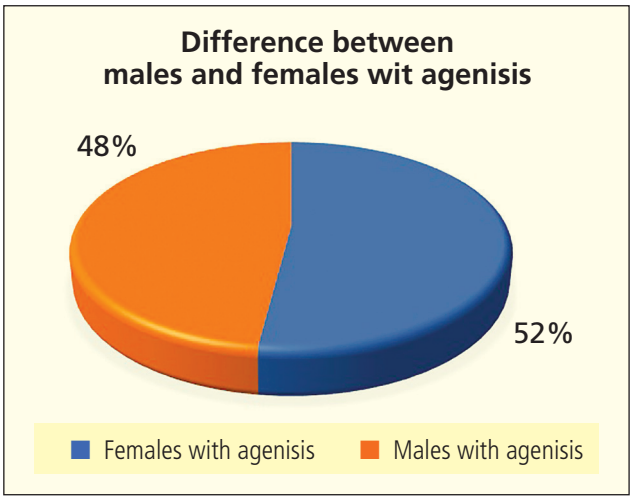


FIG. 2 Prevalence of agenesis for each sex (52% for females and 48% for males).

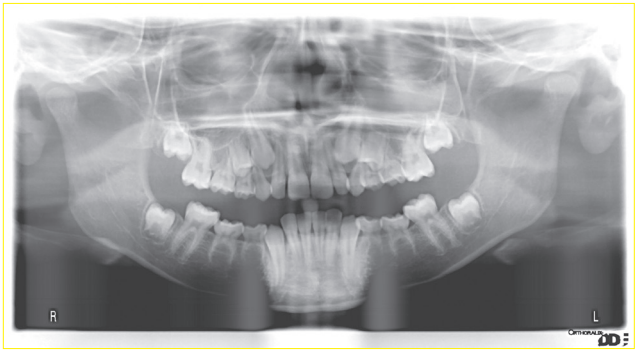


FIG. 3 This OPG of a 11-year-old patient showing agenesis of 6 teeth: 15, 25, 34, 35, 44 and 45.

Of the sample, 98 subjects — 51 females and 47 males — had agenesis (Fig. 2).

The number of teeth affected by agenesis in the same patient varied from a minimum of 1 to a maximum of 11; most subjects presented absence of 1 (43.88%) or 2 (40.82%) teeth (Fig.3).

The following graph shows how many times each tooth was absent (Fig. 4).

It is evident that the teeth most affected by agenesis were 35 and 45, both involved 30 times, followed by tooth 12, affected 27 times, and tooth 22, with involvement in 19 cases (Fig. 5). There were no patients with teeth 16, 11, 23, 26, 33, 36, 43 and 46 missing.

Graph 2 shows that the lower arch was more involved by agenesis than the upper arch, with 107 teeth absent in the mandible, and 83 in the maxillary. The third and fourth quadrants were the most involved with teeth 54 and 53 agenesis, respectively, followed by the first (46 cases) and second quadrants (37 cases).

Fifty-four patients, including 31 females and 23 males, presented agenesis in the upper arch; on the other hand, those with absence of teeth in the lower arch were 62, 28 females and 34 males.

Regarding the prevalence of agenesis between the two arches, 47 percent of the subjects presented agenesis in the maxillary arch, 53 percent in the mandibular arch (Figure 6);

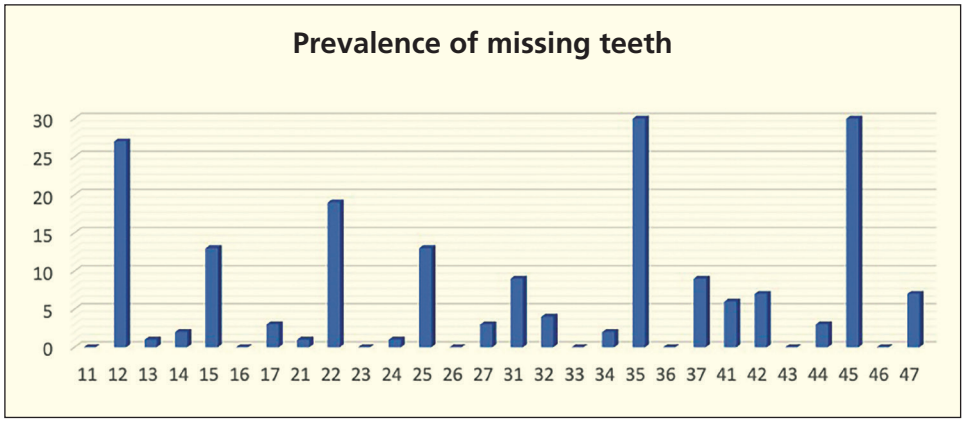


FIG. 4
Prevalence of agenesis for each tooth. The higher the line the more frequent a tooth is missing. It is evident that teeth 35 and 45 are the most frequently missing, followed by 12 and 22.



FIG. 5 OPG of a 9-year-old patient, presenting agenesis of tooth 12 with the corresponding deciduous in arch. Tooth 13 growing is visible in the position of tooth 12.

the Chi Square calculation shows was no statistically significant difference between the two arches (p= 0.245).

We calculated the number of simultaneously missing teeth in the same subject by selecting patients with a minimum of 2 up to a maximum of 4 agenesis. Patients with more than 4 agenesis were excluded, since it is difficult to recognise patterns of association in these cases. The results are shown in Figure 7. This image was realised by modifying a graph shown in a paper published by Gracco et al. [2017]. Each horizontal line connects simultaneously missing teeth in the same patient and the thickness of the line increases as the number of cases in which this association occurs increases.

The most frequent associations were teeth 12-22 and 35-45, both occurring 11 times. Simultaneous absence of 25-45 and 31-41 was found in 3 cases. Other associations observed were between teeth 37-47, 15-25, 32-42 and 15-25-35-45. All other teeth were simultaneously missing in only one case.

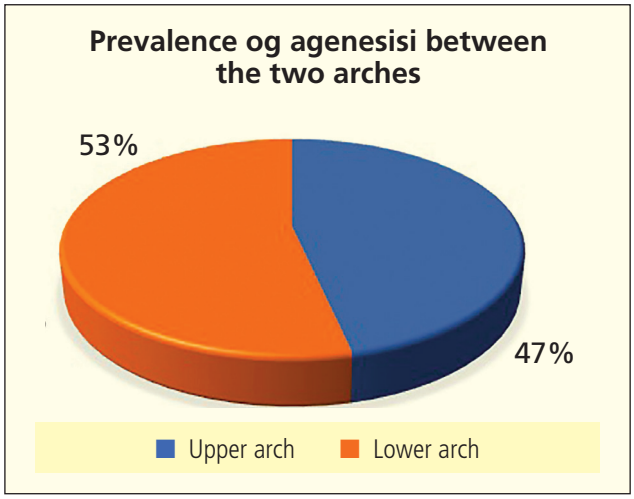


FIG. 6 Difference in prevalence of agenesis between upper (47%) and lower (53%) arch.

Discussion

A total of 98 subjects with agenesis were identified with a prevalence of 5% for females and 4.61% for males, for a total of 9.61% considering both sexes; this result is in line with what is reported in the literature [Gracco et al., 2017]. Moreover, it has been reported that the prevalence of dental agenesis in females is approximately 1.4 times higher than in males. However, in our study, there was no statistically significant difference between females (4.89%) and males (4.07%) (p=0.8252).

We compared our results with those obtained from the study conducted in different Italian areas to assess whether there were statistically significant differences within the Italian population. The only available data were from Veneto [Gracco et al., 2017] and Sardinian [Vona et al. 1993] populations. Statistical analysis showed no significant difference in prevalence between this study and the Veneto one (p=0.5216) or, even between, ours and the Sardinian one (p=0.0241), which means that there is no difference in considering Italian sample.

Finally, we compared our results with those obtained by Al-Abdallah el al. [2015], who studied the Jordanian population, to assess whether there were any differences compared to foreign populations. In this case a statistically significant difference emerged (p=0.000).

Thus, it is possible to observe that there is no statistically significant difference considering Italian samples, while evaluation of a foreign population highlights differences. Based on these results, it is possible to assume that the genetic patterns underlying agenesis are similar within the same population, but different from the others.

The prevalence of agenesis is higher in the lower arch, as reported in the literature by Gkantidis et al. [2017]. They had observed a frequency of 59.2% for the upper arch and 67.6%

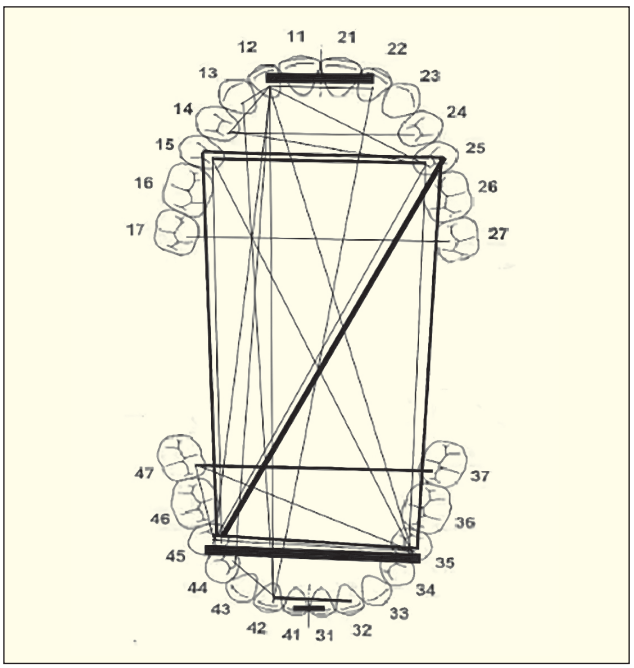


FIG. 7 Frequency of association between agenesis in the same subject. The thicker the line the more frequent is the association of agenesis between two teeth.

for the lower arch. In our study, the prevalence in the mandibular arch was 56.32% and in the maxillary arch 43.68%, confirming a higher frequency of the anomaly in the lower arch. Considering the maxillary arch, the tooth most affected by the anomaly was the lateral incisor, while in the mandibular arch it was the second premolar. Al-Abdallah et al. [2015] reported similar results: in the maxillary arch the lateral incisor presented itself as the most frequently absent tooth (87.7%), while in the mandibular arch it was the second premolar (64.3%).

In cases of bilateral agenesis, the most frequently missing teeth were the lower second premolars (11 cases) and the upper lateral incisors (11 cases). This is in line with the results of Gracco [2017], who had reported a higher prevalence of the upper lateral incisor (1.9%) than the lower second premolar (1.6%).

Conclusions

The results of this study, demonstrating a prevalence of 9.61% of dental agenesis in the population studied, showed that this anomaly has a not-negligible frequency. In detail, the teeth most frequently affected were lower second premolars followed by upper lateral incisors. The mandibular arch had a greater involvement than the maxillary one. These data are similar to those reported in literature. Orthopantomograms, taken when dental agenesis is suspected, it is possible to obtain a global view of the patient's dental arches so as to intercept any anomaly early, plan and manage the correct treatment plan in the best way, presenting all possible therapeutic options to the patient and their parents.

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