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Prevalence of Missing Lateral Incisor Agenesis in an Orthodontic Arabs Population in Israel (Arab48)

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Abstract

Tooth agenesis is defined as congenital absence of one or more teeth in primary or permanent dentition and is a common oral variation that affects a large population group. Among the missing one's, maxillary lateral incisor is more frequent causing esthetic and functional impairments in the affected individual. It might be associated with systemic problems, syndromic conditions or other oral anomalies. Management of missing lateral incisors involves a multi-disciplinary approach for rehabilitation of impaired esthetics and function. This study was carried out to determine the prevalence of congenital absence (agenesis) of maxillary lateral incisors in Arabs population in Israel (Arab48).

Keywords

Tooth Agenesis, Hypodontia, Maxillary Lateral Incisor, Congenitally Missing Teeth, Epidemiology, Arab48

1. Introduction

Many terms can be used to describe missing teeth. Anodontia is the complete absence of teeth; Oligodontia or partial anodontia means absence of six or more teeth; hypodontia denotes missing teeth, but usually less than six and often the size and shape of remaining teeth are altered as well, congenitally missing teeth or agenesis is defined as teeth that failed to develop or are not present at birth. Agenesis of any tooth can cause dental asymmetries, alignment difficulties, and arch length discrepancies but when the missing tooth is in the anterior region of the maxilla, the discrepancies can be quite noticeable.[1,2]

The maxillary lateral incisor is the second most frequently missing tooth after the mandibular second premolar even though Muller et al. found that maxillary lateral incisors experience the most agenesis (not including third molars). Agenesis of the maxillary lateral incisor is also linked with anomalies and syndromes such as agenesis of other permanent teeth, microdontia of maxillary lateral incisors (peg laterals), palatally displaced canines and distal angulations of mandibular second premolars.[1]

Woolf presented data on anomalies associated with agenesis of the maxillary lateral incisor, such as peg laterals.[2] His study sample consisted of members of the Mormon Church in Salt Lake City because of the extensive family records they keep.

Woolf studied 103 participants who had either unilateral or bilateral agenesis of the maxillary lateral incisor, and the relatives of this test group (187 families) from the same area acting as controls. Results showed that 17.7% of parents and siblings of the sample population also had agenesis of the maxillary lateral incisor or pegshaped laterals, compared to only 2.8% in the control group. Twenty-four of the 103 participants who had agenesis of the maxillary lateral incisor also had a peg-shaped lateral incisor. Members in the same family tended to show the same location and pattern of

agenesis (bilateral, unilateral or right versus left). From these results, Woolf concluded that some genotypes result specifically in agenesis of the maxillary lateral incisor, some cause agenesis of multiple teeth, and some cause agenesis of the maxillary lateral incisor and anomalies such as peg laterals. Evidence of a genetic association was demonstrated in this population; however genetic mapping was not used at the time the study was conducted in 1971 to verify genetic links.[2]

In the 1975 Symposium on Genetics, Bailit presented on variations in tooth size, gender, agenesis and race.[4] The mouth was divided into 3 'groups' per side consisting of incisors (central and lateral), premolars (first and second) and molars (first, second and third). The most distal tooth in each tooth group was shown to be the least stable, except for the mandibular central incisor, and therefore more likely to be congenitally missing. This theory of tooth instability is also known as Butler's Field Theory.[5]

Bailit theorized that the most distal tooth in a group is more influenced by environmental factors rather than genetics. He believed that genetics had a greater affect on the size of the central incisor, first premolar and first molar whereas the maxillary lateral incisor, second premolar and second molar are more affected by the environment. The last tooth to erupt in a segment (most distal) has a predetermined space in which to erupt, giving it more phenotypic flexibility. Bailit stated that except for the maxillary lateral incisors, tooth sizes are fairly symmetrical bilaterally and when a maxillary lateral incisor is missing, it is most likely the left one. At the time the paper was written in 1975, there was little knowledge about the extent to which genetics affects agenesis, but Bailit suspected it was important.

Since the development of genetic mapping, Brook et al. have shown that some genes are implicated in the agenesis of teeth, including PAX9, MSX1 and AXIN2. The PAX9 gene is on chromosome 14 with a controlling factor for dental development and mutations related to missing teeth.[6]

Peck, Peck and Kataja linked palatally displaced canines, transposition of mandibular lateral incisors and canines and maxillary canine and premolar transposition with agenesis.[7] They studied 161 subjects and found that patients with maxillary canine-first premolar transposition were 13 times more likely (26%) to have agenesis of a maxillary lateral incisor. They agreed with Brook et al. that PAX9 and MSX1 mutations contribute to tooth agenesis [6], however they also pointed out that the PAX9 and MSX1 genetic mutations are associated with posterior tooth agenesis while a strong causative gene mutation for anterior agenesis has yet to be found. Peck, Peck and Kataja believe signaling proteins such as bone morphogenic proteins (BMP) and fibroblast growth factor (FGF) may be responsible for agenesis early in embryonic development.[7,8]

Pirinen et al. focused their research on palatally displaced canines and agenesis of incisors and premolars.[9] They examined 106 patients (77 females, 29 males) who had undergone surgical exposure of a palatally impacted canine to determine whether they also expressed agenesis. One hundred and ten first-degree relatives of these patients and 93 second-degree relatives were also examined while pedigrees were created to establish a genetic link. Results showed that 36% of the test patients exhibited agenesis, which is 4.5 times the population prevalence. First and second-degree relatives showed 19-20% agenesis or 2.5 times the population prevalence. This illustrates that there is a strong genetic link between palatally displaced canines and agenesis.[9]

Dempsey and Townsend aimed to quantify the relative contributions of the environment and genetics to the mesio-distal (MD) and buccal-lingual (BL) sizes of teeth in monozygotic and dizygotic twins.[10]The MD and BL of 596 participants' teeth were measured on plaster casts. Different model analyses were created to separate twin pairs of males and females, monozygotic twins that were raised apart (different environments), and dizygotic twins. Mandibular lateral incisors were found to be the least sexually dimorphic permanent teeth. For most teeth, the variation in crown size can be explained by the additive genetic and unique environmental variation. Environmental influences on tooth crown size can be substantial, but heritability of most crown sizes is moderate to high.[10]

Arte et al. also found strong genetic relationships between hypodontia and tooth anomalies such as ectopic maxillary canines.[11] They studied 11 people (aged10-36 years) with hypodontia of 1 to 6 permanent teeth and their relatives, totaling 214 Finnish individuals. The mean number of tooth agenesis in the test group was 2.3 and 1.7 in their families indicating a strong genetic link. Data was collected retrospectively through dental history and radiographs and the controls were established with published population prevalence. Results showed 4.5-4.9 times the occurrence of hypodontia in first and second degree relatives (39% and 36% respectively). They also found an equal maternal and paternal inheritance. Rotated premolars and ectopic permanent canines were seen more frequently in patients with hypodontia and their families; 2 to 3 times that seen in the general population. The authors concluded that incisor-premolar hypodontia is associated with many dental anomalies and is transmitted in an autosomal dominant manner.[11]

Since the development of genetic mapping, Brook et al. have shown that some genes are implicated in the agenesis of teeth, including PAX9, MSX1 and AXIN2. The PAX9 gene is on chromosome 14 with a controlling factor for dental development and mutations related to missing teeth.[6,12] Brook et al. measured the tooth sizes on maxillary and mandibular dental casts in the test group, 10 people with a known PAX9 mutation in one family and 10 people in a control group matched for sex, age and ethnicity, who were not related to the test group and did not have the PAX9 mutation. Differences in the test group with the mutation and hypodontia were found; these teeth were significantly smaller than controls. Canines and first molars were least affected in the test group. This contradicts Bailit's theory that genetics mostly affects the first tooth in each group: the central incisor,

canine, first premolar and molar.17 Brook et al. found that the second tooth in each group was more affected by the PAX9 mutation. The study concluded that the PAX9 mutation not only decreased tooth number, but also tooth size throughout the dentition.[12]

Hypodontia (excluding the third molar) is relatively common findings in different populations. Its frequency varies from 2.3 to 8% (5, 13). Maxillary lateral incisors were the second most commonly absent teeth as reported by several authors (Claton, 1956 (2); Glenn 1964 (3); Ingervall wt al., 1972 (4); Wisth et al., 1974 (5); Rolling, 1980(6)). Muller et al/, 1970 (7), found that in those people with missing one tooth, the maxillary lateral incisors are congenitally absent in 46.4 % of U.S.A. subjects.

Magnusson TE., 1977 (8), found that agenesis of maxillary lateral incisor was present in 18% after examining 1116 Icelandic students.[13,14,15]

In Saudi Arabia, the prevalence of hypodontia and peg-shaped maxillary lateral incisors were studied by Al-Emran et al. 1990 , in 500 Saudi Arabia male students within the age range 13-14 years, he reported that agenesis of maxillary lateral incisor was present 0.6%. Whereas, deviation from normal dental morphology (peg-shaped) maxillary lateral incisor was observed in 4% of the sample.[16]

Salama and Abdel-Megid, 1994 , conducted a study on the prevalence of agenesis and peg-shaped maxillary lateral incisors in 1300 Saudi Arabia male students. They found that agenesis of maxillary lateral incisor was present in 9 %. Peg-shaped maxillary lateral incisor was found in 0.7 % of the total sample size.[17]

Both of the previous studies were done in the Central Region, (Riyadh city), and further studies in the eastern region are needed to confirm their findings m

The purpose of this investigation is to determine the prevalence of congenital absence (agenesis) maxillary lateral incisor among Arabs population in Israel. And to compare the data with other similar studies.

2. Materials and Methods

We conducted a retrospective study of all orthopantomograms (OPGs) of 2200 Palestinian patients aged 12 to 39,5 years (Mean age #16,2), taken between 2006 and 2013, which were available in the Center for Dentistry, Research & Aesthetic, Jatt, Almothalath, Israel. Ambiguous OPGs of subjects with no proper record of date of birth and poor quality image were excluded.

All students attending on the day of examination were examined. Inclusion criteria were as follows:

1.Palestinian Arabian origin.

2. No pervious history of maxillary lateral incisor extraction

3. No pervious restorative reshaping or crowning of the maxillary lateral incisors

4. No pervious orthodontic treatment.

The clinical examination was carried out in the our dental center in good daylight using disposable tongue depressors to retract the lips if needed during anterior segment examination.

The patient were questioned about possible earlier extractions and those with positive history were excluded from the study. If the lateral incisors were missing and the patient has no positive history of pervious extraction, the patient was referred to the our center for diagnostic panoramic radiograph to be taken.

Agenesis of lateral incisor was determined from radiograph; patient with impacted maxillary lateral incisors were also excluded from the study.

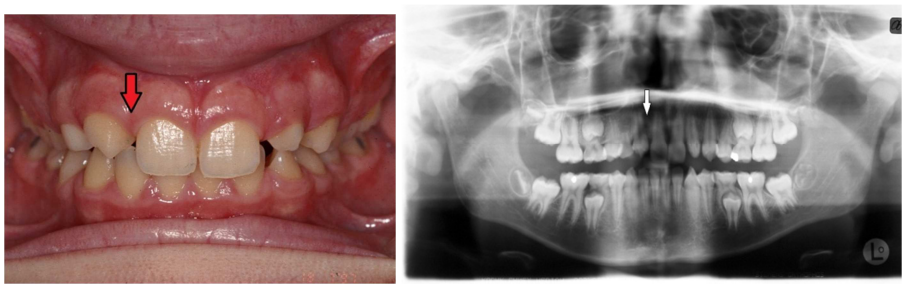

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Fig. 1a, b. *Unilateral missing lateral Incisor.*

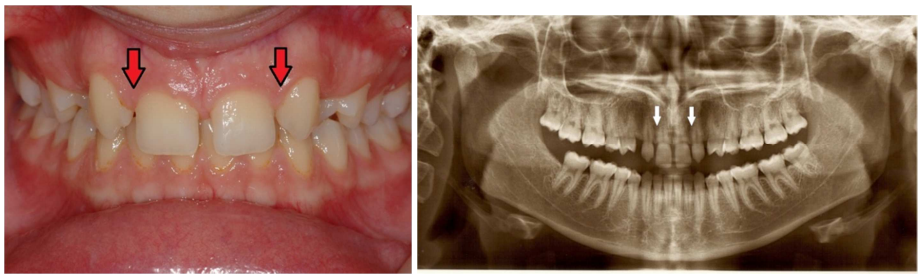

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Fig. 2a, b. *Bilateral missing lateral Incisors.*

3. Results

Table 1. *Gender distribution of patients treated.*

Treated (Orth.)	N=2200	%
Female	1354	61.60%
Male	846	38.40%

Of the 2200 patients, 846 were males (38,4%) and 1354 were females (61,6%) (Table 1)(Fig.3); the mean age was 16,2years, ranging from 10,2 to 39,5 years. (Table 2).

Table 2. *Means age Hypodontia.*

Age, Impacted	Min	Max	Avg
	10.2	39.5	16.2

Of the 2200 subjects (1354 females- [61,6%], 846males -[38,4%]) exa-mined, 24(13 females 54,[17%], 11 males) were found to have MLI agenesis. Thus, the prevalence of MLI agenesis in our sample was 2,6%, and 0,6%per cent of the females and 0,5% of the males were affected.

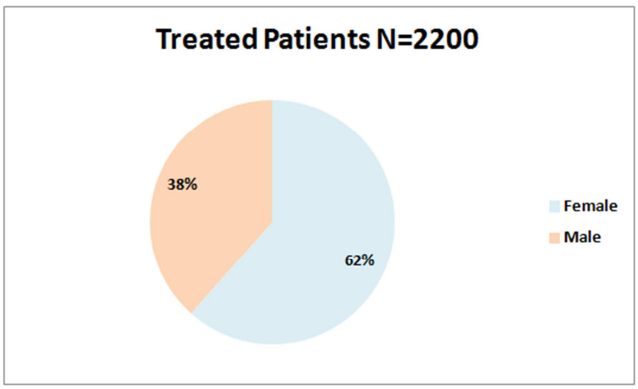

Fig. 3. *Gender distribution of patients treated.*

Table 3. *Patients with Missing Lateral Teeth N=24 .*

Missing Lateral	N=24	%Missing
Female	13	54.17%
Male	11	45.83%

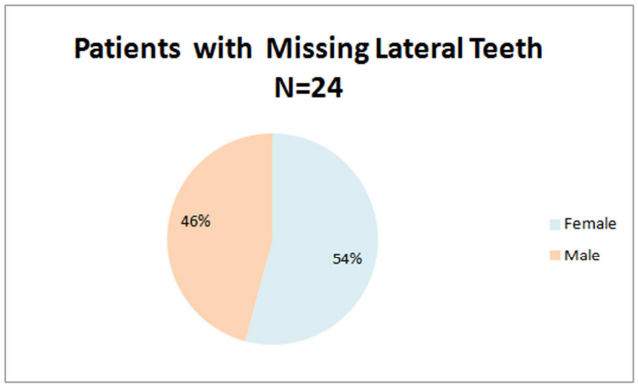

Fig. 4. *Patients with Missing Lateral Teeth.*

Table (4) presents, the percentage distribution of normal, maxillary lateral incisor values among the 2200 patients . 2176 (98,90%) of the sample had normal lateral incisors, 24 (1,09%) had congenital absence (agenesis) maxillary lateral incisors.

Table 4. *Number of Persons Having Missing Lateral Incisors.*

	Female	Male	Total
Missing lateral incisors	13	11	24
Normal lateral incisors	1341	835	2176
Total	1354	846	2200

Table 5. *Number OF Examinees with Unilaterally and Bilaterally Missing Lateral Incisors.*

	Female			Male		
Tooth	n	% (N=57)	% (N=2200)	n	% (N=57)	% (N=2200)
12	3	5.26	0.14	2	3.51	0.09
22	3	5.26	0.14	2	3.51	0.09
12 & 22	7	12.28	0.32	7	12.28	0.32
Total	13	22.8	0.6	11	19.3	0.5

Bilateral agenesis of MLI occurred in 14 subjects (0,64%) and unilateral agenesis in 10 patients (0,45%). Of those presenting with unilateral agenesis of the MLI, 6(60%) were on the right side and 4 (40%) on the left side. No gender difference was observed in the side-to-side distribution of MLI agenesis ($p > 0.05$).

4. Discussion

The number of patients seeking orthodontic treatment in Arabs population in Israel has increased markedly during recent years. Therefore it is important to have relevant epidemiological data on different types of malocclusion in order to estimate the total need for treatment.

In the present study, analysis of a large sample was done in order to obtain a clear and valid picture of the distribution pattern of congenital absence (agenesis) of maxillary lateral incisor in the Arabs population in Israel.

Investigators in other populations (United State, German, Iceland, and Swedish populations) reported also different prevalence pattern of agenesis and peg-shaped maxillary lateral incis ors. This indicates that differences do exist between various populations. The most likely expansion is the differences in racial and ethnic origin.

Sofaer et al. in 1971 provided one theory on tooth size and agenesis. He measured the teeth of 17,000 high school students in Hawaii ranging in age from 11- 20 years, some with agenesis of the maxillary lateral incisor and some with a fullcomplement of teeth. Teeth were measured intra-orally with oral proof of agenesis; no radiographs were taken of the subjects. Peg laterals were associated with a smaller than normal central incisor adjacent to it. A missing lateral incisor tended to have a larger than normal central incisor adjacent. Central incisors were more asymmetrical than normal in cases of a missing lateral incisor and were also slightly, but not significantly, larger than normal when maxillary lateral

incisors were bilaterally missing. Sofaer hypothesized that the size of the lateral incisor depends on the amount of space the central and canine have left for it during primordial development. Since the canine and central incisors develop before the lateral incisor, he theorized that it must compete with its neighbors for size. Sofaer believed that inadequate environment, poor primordium or both may cause this tooth size asymmetry.[18]

In 2001, Basdra et al. investigated a relationship between Class III and Class II division 1 malocclusions who had not received orthodontic treatment and congenital tooth anomalies. [19] They examined 215 total patients with these malocclusions looking for: maxillary incisor hypodontia, maxillary canine impaction, transpositions, supernumerary teeth, and tooth agenesis. The age range of the patients was 7.2-45.8 years, roughly half males and half females. A dental history and radiographs were used to confirm the tooth anomalies. While 5.5% of the Class III patients and 1.9% of the CL II division 1 patients presented with agenesis of their maxillary lateral incisors, the frequency was not different from that of the general population. In fact, none of the anomalies in these two malocclusion groups showed variance from that in the normal population; results were not statistically significant[19].

Le Bot's study found similar results as Baidas and Hashim. [20] He measured the teeth of 200 French males with maxillary lateral incisor agenesis confirmed radiographically. The sum of the bucco-lingual and mesio-distal dimensions of maxillary teeth in dental arches with the agenesis of a lateral incisor were shown to be significantly smaller than normal. Interestingly, dental arches in the test group who experienced 'peg' laterals with no agenesis expressed even smaller teeth than the group with agenesis. Premolars and canines within the arch showed the greatest reduction in dimensions when the maxillary lateral was missing; molars were least affected. Le Bot also noted that 39.6% of the test sample with agenesis had a missing a third molar compared to 12.4% in the control group.[20,21]

In contrast to Sofaer, Baidas and Hashim found that maxillary anterior teeth were smaller than normal in patients with unilateral or bilateral agenesis of maxillary lateral incisor.[21] Thirty dental cases were measured, 12 had a missing lateral incisor unilaterally, 18 had missing lateral incisors bilaterally. However, the test population race was not disclosed and male and female measurements were analyzed together.The authors used Bolton's analysis4,8 and Wheeler's index37 to evaluate anterior maxillary and mandibular tooth size ratios. The Bolton Index ratios were larger forpatients with bilateral or unilateral agenesis of a maxillary lateral incisor (79.1% and 81.7% respectively with the norm of 77.2%); thus demonstrating lack of maxillary tooth structure. The reliability of Bolton ratios on racially unknown study population should be questioned, mainly because Bolton ratios have been shown to best apply toCaucasian females.[22]

In 2007, Othman and Harradine studied tooth size discrepancies in an orthodontic population to determine how frequently they occur, the amount of discrepancy that is clinically significant and if these discrepancies can be visually evaluated without measurement (recommended by Bosio39 and Proffit27). [23]Their population did not contain agenesis, but complete, permanent dentitions. They measured the mesio-distal widths of teeth on 150 (96 female, 54 male) pretreatment casts from Caucasian patients and used the Bolton Analysis4 to calculate tooth size discrepancies. Othman and Harradine found that in this orthodontic population, 17.4% of people had anterior ratios and 5.4% had total tooth-width ratios greater than 2 standard deviations from Bolton's norms. They believe that Bolton's selection criteria may have skewed his results because he chose his sample based on 'excellent occlusions' , which is not typical for an orthodontic practice. The authors also determined that 2mm of tooth size discrepancy within an arch (1mm per side) is considered clinically significant, compared to other literature stating a discrepancy of 1.5mm per ach is clinically significant.[24]They also concluded that visualization of a tooth size discrepancy by comparing the size of the maxillary lateral incisor to the size of the mandibular lateral incisor is not an accurate method of evaluating tooth size discrepancies. Thirty percent of teeth visually examined this way were deemednot to have a discrepancy even though measurements showed they did have a significant tooth size deficiency.

Many other studies, we found a significantly higher prevalence of MLI agenesis in females. Our findings that both MLIs were just as likely to be missing as one incisor, and when one lateral incisor was missing it was likely to be on the right side, agree with previous researches . However, we urge caution when interpreting these results because of the methodological shortcomings in retrospective studies of orthodontic populations.[25]

Previous studies have shown that tooth age-nesis may be related to other dental anomalies such as microdontia or peg-shaped incisors, taurodontism, transposition, supernumerary tooth, ectopic eruption, retained primary tooth, and ectopic eruption. However, agenesis of MLI and associated dental anomalies were limited in the literature. Most of the papers published about MLI agenesis investigated reduced crown size or peg shaped form of the contralateral MLI among the subjects with unilateral absence of this tooth.

Pinho et al. investigated other associated developmentally absent teeth and supernumerary tooth. Although no supernumerary tooth was found, they found that 12.8 per cent of the subjects with MLI agenesis had absence of other teeth and most frequently observed missing teeth were maxillary and mandibular premolars. The prevalence of the subjects with agenesis of other teeth (9.6 per cent), in this study, was very close to the data reported by Pinho et al. and the missing teeth were maxillary and mandibular premolars (63.6 per cent) and mandibular central incisors (36.4 per cent).[26,27,28,29]

Celikoglu et al. [30]reported MLI-canine transposition in the cases of MLI agenesis and Peck et al. [7] showed transposition in the mandible. In this study, one subject with MLI-canine transposition in the same side with MLI agenesis

was observed. Additionally, we found 6 subjects with dilacerations, 5 with the impaction of maxillary canines, 1 with a supernume-rary tooth, and 1 with a transmigrated maxillary canine. Supernumerary tooth was an extra premolar in the same side with the MLI agenesis. In addition, transmigration and transposition of the maxillary canine were also in the same side with the MLI agenesis.

In 78.7 per cent of the patients with the agenesis of MLIs, the space was orthodontically closed, while in the remaining 21.3 per cent the space was orthodontically maintained for prosthetic replacements and implant placement. The lateral incisor space was closed in the patients with crowded arches, while space was maintained in the patients with uncrowded arches[31]. Since crowding was present in the study group and implant treatment is deferred until the jaws have stopped growing to avoid the complications caused by implants , the space was orthodontically closed in most of the patients. Robertsson et al. [32] investigated the aesthetics according to the opinions of the patients, occlusal function, and periodontal health in subjects with one or two MLI agenesis who had received either orthodontic space opening or closure followed by a modern prosthetic replacement for the MLI agenesis. The authors indicated that orthodontic space closure produced treatment results that appear to be reasonably stable, and better accepted by the patients than prosthetic replacements.

Orthodontic patients do not necessarily reflect the number of individuals in the population with tooth agenesis, this will be dependent on the availability of orthodontic treatment and its uptake in this particular population. However, retrospective studies rely on good record keeping and orthodontic patients often have more complete records. Thus, some reports have shown the prevalence of tooth agenesis in orthodontic patients.

To summarize the studies presented on tooth size and agenesis: tooth size discrepancies do exist in combination with agenesis of a maxillary lateral incisor. Central incisors adjacent to the missing lateral incisors were larger than 'normal' in an early, intra-oral study, whereas other studies measuring teeth on dental casts showed smaller than average maxillary anterior teeth when the lateral incisor was missing. Premolars and canines within the arch with agenesis have also been shown to be smaller than normal and third molar agenesis is more common as well.

In an orthodontic population without agenesis, tooth size discrepancies are fairly common.

5. Conclusions

1. The prevalence rates for lateral incisor agenesis 1,1%, respectively, in Arabas populationin Israel.

2. The present study also shows that Arabs population in Israel had less agenesis maxillary lateral incisors than Caucasians.

3.The prevalence of missing teeth was more common is females than males.

4. The prevalence of missing teeth was more bilateral than unilateral teeth.

In the diagnosis of agenesis of maxillary lateral incisors it is necessary to perform a good clinical examination and subsequent radiographic confirmation in order to observe not only the absence itself but also all the anomalies that may be associated.

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