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Prevalence of developmental dental anomalies in Serbian orthodontic patients

Заступљеност развојних аномалија зуба код ортодонтских пацијената у Србији

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SUMMARY

Introduction/Objective The aim of this study was to evaluate the prevalence of developmental dental anomalies (DDA) in Serbian orthodontic patients.

Methods: The sample comprised of 1,001 panoramic radiographs of orthodontic patients, older than seven years of age, taken as a part of the initial diagnostic procedure at the Clinic of Orthodontics, School of Dental medicine in Belgrade. The DDA that could be diagnosed accurately on panoramic X-rays were documented. Descriptive analysis was used to determine prevalence and sex distribution of DDA. The Pearson χ^2 test and Fisher's exact test were used to compare number of affected teeth in males and females (level of significance was 95%).

Results: The prevalence of DDA in Serbian orthodontic patients was 34.8% (15.5% males and 19.3% females). Impactions were present in 16.5%, hypodontia in 12.9%, hyperdontia in 4.4%, microdontia in 2.9%, macrodontia in 1.8% and transposition in 0.8% of patients. Maxillary canines were the most frequently impacted teeth. Maxillary second molars were more prone to impaction in females ($p < 0.05$). Impacted incisors were more prevalent in maxilla, premolars and second molars in mandible. The most commonly missing teeth were upper left second premolars. Mesiodens was the most frequently found supernumerary tooth.

Conclusion: We reported a high a rate of DDA in Serbian orthodontic patients, more in females than males. The most frequently observed DDA were impaction, tooth agenesis, hyperdontia, microdontia, macrodontia and transposition. All investigated DDA were more frequently present in females, except hyperdontia. Current findings could offer a foundation for epidemiological studies on DDA prevalence.

Keywords: developmental dental anomalies; orthodontics; hypodontia

САЖЕТАК

Увод/циљ Циљеви овог истраживања су били да се испита заступљеност развојних аномалија зуба код ортодонтских пацијената у Србији.

Методе: Узорак су чинили 1.001 ортопантомографски снимак ортодонтских пацијената старијих од седам година са Клинике за ортопедију вилица, Стоматолошког факултета у Београду. Бележено је присуство развојних аномалија за чију дијагностику је потребан само ортопантомографски снимак. За испитивање заступљености развојних аномалија зуба коришћена је дескриптивна статистичка анализа. χ^2 тест је коришћен ради поређења броја зуба са аномалијом између полова (степен значајности 95%).

Резултати: Развојне аномалије зуба су биле заступљене у 34.8% ортодонтских пацијената (15.5% мушкараца и 19.3% жена). Импакције зуба су биле присутне код 16.5%, хиподонција код 12,9%, прекобројни зуби код 4,4%, микродонција код 2,9%, макродонција код 1,8% и транспозиција код 0,8% пацијената. Очњаци у горњој вилици су били најчешће импактирани зуби. Горњи други молари су били више склони импакцији код жена ($p < 0.05$). Документовано је више импактираних секутића у горњој вилици, а премолара и других молара у доњој вилици. Најчешће су недостајали горњи леви премолари. Од свих прекобројних зуба, мезиоденс је најчешће био уочен.

Закључак: Приказали смо постојање високе учесталости развојних аномалија зуба код ортодонтских пацијената у Србији са већом израженошћу код особа женског пола. Најчешће присутне аномалије била су импакција, хиподонција, хипердонција, микродонција, макродонција и транспозиција. Све аномалије су биле учесталије код жена, осим у случају прекобројних зуба. Резултати садашње студије могу бити полазна тачка за епидемиолошке студије о учесталости развојних аномалија зуба.

Кључне речи: развојне аномалије зуба; ортодонција; хиподонција

INTRODUCTION

Developmental dental anomalies (DDA) occur during the period of teeth development. The etiology is complex and multifactorial. It involves genetic and environmental influences,

as well as variation in sex distribution. DDA are presented as irregularities in tooth number, size, shape and structure, and altered teeth eruption. The complexity of tooth development is influenced by over 300 genes, mutations and/or localized or generalized insults (trauma, infection, therapeutic irradiation, low birth weight, vitamin D deficiency, metabolic and hormonal disturbances, as well as nutrition and available space in the dental arch). The outcome of these influences could be the presence of isolated or combined DDA in a person [1, 2]. Persons with DDA tend to have orthodontic, functional, and esthetic problems. The early discovery and information of prevalence and association of dental abnormalities with sex and type of teeth are important information for dental practitioners.

Epidemiological studies investigating the prevalence of DDA have been conducted all over the world with variation in results [3, 4, 5]. Only a few recent studies, mostly on a particular type of DDA, were done in Serbia. Authors investigated the prevalence of hypodontia in Serbian schoolchildren [6, 7]. Two studies reported on the prevalence of structural dental anomalies (amelogenesis imperfecta and molar -incisor hypomineralization [8, 9]. To the best of our knowledge, any other studies investigating more types of DDA in Serbian population have not been conducted.

The aim of this study was to evaluate the prevalence and sex distribution of developmental dental anomalies in Serbian orthodontic patients.

METHODS

Sample

This retrospective cross-sectional study was comprised of 1,324 panoramic radiographs of patients older than seven years of age referred to the Clinic of Orthodontics, School of Dental Medicine, University of Belgrade from all over Serbia. Digital panoramic radiographs were taken as a part of the initial diagnostic examination in 2016. Only high-quality films of

patients with no craniofacial abnormalities and syndromes associated with DDA (including cleft lip and palate), previously extracted permanent teeth, a trauma in the orofacial region, and previous orthodontic treatment with fixed appliances, were included in the sample. Consequently, a sample comprised of 1,001 panoramic radiographs (459 male and 542 female patients). Experienced orthodontist and pedodontist were calibrated for the assessment of radiographs. Only tooth abnormalities that could be diagnosed precisely and solely on panoramic X-rays were documented. The DDA with a high probability of poor diagnosis without previous clinical examination and/or additional radiographs were excluded from the evaluation, such as: 1) Anomalies of tooth structure - hypomineralization, amelogenesis imperfecta, and molar-incisor hypomineralization (MIH); 2) Root deformation and number, concrescence and dilaceration; 3) Rotation. Third molars were excluded from the evaluation due to the high incidence of variation in morphology, size, and position.

We evaluated panoramic radiographs for the following DDA:

1) Hypodontia-developmentally missing teeth (tooth agenesis) was diagnosed by counting present teeth when no sign of tooth formation existed. Oligodontia was defined when more than six teeth were missing;

2) Hyperdontia (supernumerary teeth)-additional teeth were present on the radiograph. They may be observed as teeth with normal size and shape, or with smaller size and atypical form;

3) Mesiodens-supernumerary tooth localized in the anterior region of maxilla;

4) Tooth transposition-two adjacent teeth changed their position partially or completely in dental arch [10];

5) Microdontia-teeth are smaller than average. Microdontia of maxillary lateral incisor was recorded when the maximum mesiodistal crown diameter was smaller compared to the same dimension of opposing mandibular lateral incisor in the same patient [11];

6) Macrodontia was referred to the tooth that was found to be immensely larger than the

average one [12];

7) Impaction was defined in cases when physical barrier existed, and/or tooth had an orientation that prevented its emergence [13]. Canines were not evaluated for impaction in children younger than ten years of age due to the possibility of misdiagnosis.

This study was done in accord of the institutional Committee on Ethics.

Statistical analysis

The statistical analyses were performed using Statistical Package for Social Science (SPSS software package, version 22.0; SPSS Inc., Chicago, IL, USA). The descriptive statistical analysis was used to evaluate the prevalence of DDA and sex distribution. The Pearson Chi-square test and Fisher's exact test were used to compare number of teeth affected by anomalies in males and females. The level of significance was set at 95% with confidence interval $p < 0.05$.

RESULTS

We analyzed panoramic radiographs and charts of 1001 orthodontic patients (45.8% males and 54.2% females). At least one dental anomaly was found in 34.8% (n = 348) of patients. The distribution of dental anomalies by sex showed that females were more affected than males (19.3% *vs*.15.5%). The prevalence of investigated developmental dental anomalies of number, size, and position is presented in **Figure 1**. The location, number of teeth affected by DDA in the upper and lower jaw and comparison between males and females are presented in **Table 1 and 2**.

Abnormalities of tooth number

Tooth agenesis was the most frequent abnormality of tooth number presented in 12.9%

(n = 129) of all patients (5.5% of males and 7.4% of females). Supernumerary teeth, including mesiodens, were observed in 4.4% (n = 44) of subjects (2.4% of males and 2.0% of females). A total of 2.5% (n = 25) patients had mesiodens (2.8% males and 2.2% females). The rest of supernumerary teeth was reported in 2.4% of patients. Prevalence of abnormalities of tooth number in male and female orthodontic patients is presented in **Figure 2**. The most commonly missing tooth was upper left second premolar (n = 46 teeth), followed by upper right and lower right second premolar (37 teeth in both right quadrants). In the anterior region of maxilla, lateral incisors showed the highest prevalence of agenesis (n = 40 teeth). We found 17 lateral incisors missing on the left side, and 23 on the right side of maxilla. In the anterior region of the lower jaw, agenesis of incisors was the most frequent finding (21 teeth). First molars were not affected by agenesis. More second molars were missing in the lower jaw compared to the upper jaw (22 *vs*. 15 teeth). Oligodontia was reported in one female patient (**Table 1 and 2**).

Abnormalities of tooth position

Tooth impaction was the most frequently found dental abnormality (16.5%). The number of male and female patients with anomalies of tooth position is presented in **Figure 3**. The high number of impacted canines in the upper arch is documented in current study (107 teeth). We found 49 impacted canines on the right side, and 58 on the left side. Bilaterally impacted canines were present in 24 patients. Only 11 mandibular canines were impacted (five on the right side, and six on the left side). More impacted premolars were found in the lower jaw. The only statistically significant difference in the number of teeth affected by DDA between males and females was found in the number of impacted maxillary second molars ($p < 0.05$) (**Table 1 and 2**).

Abnormalities of tooth size

The DDA affecting tooth size were present in 4.7% (n = 47) of all patients in the sample. Prevalence of microdontia and macrodontia in male and female orthodontic patients is presented in **Figure 4.** The location, prevalence, and sex distribution of teeth affected by an abnormality in size are presented in **Table 1 and 2**.

DISCUSSION

The present study assessed sex distribution and prevalence of selected DDA in the sample of 1,001 orthodontic patients. Numerous studies presented epidemiological data and prevalence of DDA in either general population or pediatric and orthodontic patients. They vary in selection of methods, sample size, number of included anomalies, and results. The size of our sample was found to be either similar or larger in number of subjects, comparing to recently conducted investigations. Furthermore, the studies with the same purpose, conducted in different parts of the world, reported at least one dental anomaly in 5.4–45.7% of subjects [4, 14–17]. The prevalence of DDA in the present study was 34.8%, which may be because the sample consisted of patients referred to orthodontic treatment. Multifactorial etiology of dental anomalies, ethnical differences, and selection of DDA investigated in the study, inclusion and exclusion criteria contribute to the diversity of results.

Abnormalities of tooth number

Agenesis of one or more teeth could create malocclusions and esthetic and functional problems. Missing teeth were the most frequent abnormality of tooth number in the present sample of Serbian orthodontic patients (12.9%). The overall prevalence of missing teeth in recent studies was 0.027-21.6% [14, 16, 18–22]. Such considerable differences in results could be explained by variation in sample composition and size, ethnicity and methodology.

In a systematic review of the literature, Rakhshan and Rakhshan [20] reported a significantly higher number of patients with tooth agenesis in the samples comprised of orthodontic patients, in comparison to the epidemiological samples and samples of dental patients. They argued higher prevalence of anomalies in patients seeking orthodontic treatment. The only two recent epidemiological studies in Serbia found a lower prevalence of missing teeth (6.28% and 5.34% respectively) in comparison to our results [6, 7]. The high rate of hypodontia in Serbian orthodontic patients in a present study could be due to the nature of sample composition. Patients with the most challenging malocclusions, in need of potentially complicated and multidisciplinary treatment approach are almost automatically referred to the Clinic of Orthodontics. The present finding of more females than males with hypodontia (7.4% *vs*. 5.5%) supports the documented sex differences in the association between sex and hypodontia, microdontia, hyperdontia and macrodontia. Females are more affected by tooth agenesis and microdontia, while more supernumerary and large teeth are expected to be found in men (1:1.5 ratio) [1, 23]. Previous studies in different world regions offered conflicting results regarding sex distribution of patients with missing teeth [15, 16, 19]. However, our findings are in agreement with the results of sex distribution in the Serbian population (5.34–6.28%) [6, 7]. In addition, the location of teeth agenesis is in relationship to teeth position in morphogenic field, i.e. to the most distal tooth in the group affecting second premolars and lateral incisors, as well as third molars [1]. Thus, these teeth are frequently affected by agenesis (4.28–7.52%) which is in accordance with our results [4–7, 18]. A rare occurrence of oligodontia was reported in the Italian population (0.08%) which is in agreement with our result (0.09%) [24].

Contrary to the high prevalence of hypodontia, supernumerary teeth are less frequently found in healthy individuals (0.5–3.8%). The prevalence of supernumerary teeth in our sample was 4,4%, slightly higher than in recent studies [24, 25, 26]. The etiological pattern of

sex distribution in association with supernumerary teeth is the opposite of hypodontia [1]. Males are more prone to the formation of supernumerary teeth than females, which is in agreement with our findings [24, 27]. Mesiodens was the most frequently detected supernumerary tooth on panoramic X-rays in the present study. The lower prevalence of mesiodens was reported in Italian non-orthodontic subjects and French orthodontic patients (0.05% and 0.66%) [15, 24].

Impaction

The prevalence of patients with tooth impactions in the current study was high (16.5%) in comparison to the results of recent studies (2.6–7.1%) [15, 16, 28]. The highest rate of tooth impaction was found in maxillary canines, followed by maxillary central incisors, mandibular premolars and second molar. In the present study, unerupted maxillary incisors were more frequently found in female subjects compared to males, which is not in agreement with the previous report [29]. The prevalence of patients with impacted canines was 10.7% in the present study, in comparison to findings in the general population ranging from 0.6–8.4% [4, 16, 24]. The higher rate of impaction in the current study is probably due to the composition of the sample comprised of persons referred to orthodontic treatment. Females were more affected by impacted maxillary canines compared to males (9.6% *vs* 6.9%). Patients, especially females, perceived missing tooth in the anterior region of maxilla as an aesthetic problem, which motivates them to seek out orthodontic treatment.

Transposition

The maxillary canines and first premolars were found in complete transposition in four males and four females. Only a few recent studies reported a low prevalence of transposition (0.09%) which is in agreement with our findings (0.08%) [16, 30].

Microdontia and Macrodontia

Sogra et al. [16], found microdontia in 1.6% of Iranian orthodontic patients, while in a smaller sample, Baron et al. [15], reported 2.55%. Microdontia in Serbian patients was present in similar number of patients predominantly affecting maxillary lateral incisors. Low prevalence of macrodontia was reported in Iranian subjects (0.02%) which is in agreement with the results of our study (1.8%) [15].

Limitations

The study has a few limitations. Firstly, we assessed archived files of patients at the Clinic of orthodontics in 2016. The recruitment of patients could not be considered random since patients were already pre-selected from the general population and referred to orthodontic treatment. Secondly, only charts and panoramic radiographs were used to evaluate DDA. That implied assessment of the sample for only selected DDA. In order to find the prevalence of all types of developmental dental anomalies, more extensive use of diagnostic methods should be included. Only DDA that can be observed with 100% accuracy on panoramic radiographs were reported making them more relevant than the findings of the rest. Third; DDA were reported in the sample of patients older than seven years of age. Dental abnormalities, such as impaction of canines and second molars, and agenesis of second premolars could not be observed in younger age groups. This could suggest a possible disparity in the diagnosis of DDA. Forth, although, microdontia and macrodontia were evaluated by accepted reliable diagnostic method (visual examination and comparison), no additional confirmation was obtained from measurements on study models.

Despite the limitations, present findings could offer a foundation for much needed extensive epidemiological studies on DDA prevalence, sex distribution and association among different dental irregularities in the general population in Serbia and worldwide.

Furthermore, this study provides information, which is of importance for dental practitioners.

CONCLUSIONS

The prevalence of developmental dental anomalies in Serbian orthodontic patients was 34.8%. At least one tooth anomaly was found in 15.5% of males, and 19.3% of females. The most frequently observed dental abnormality was tooth impaction, followed by tooth agenesis, hyperdontia, and anomalies in tooth size and transposition. All investigated developmental dental anomalies, were more frequently present in females, except supernumerary teeth. The most commonly missing tooth was upper left premolar. The maxillary canines had the highest impaction rate. Mesiodens was the most frequently found supernumerary tooth. The transposition of upper canine and first premolar was rare. The anomalies of tooth size predominantly affected incisors.

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Figure 1. Prevalence of developmental dental anomalies in Serbian orthodontic patients

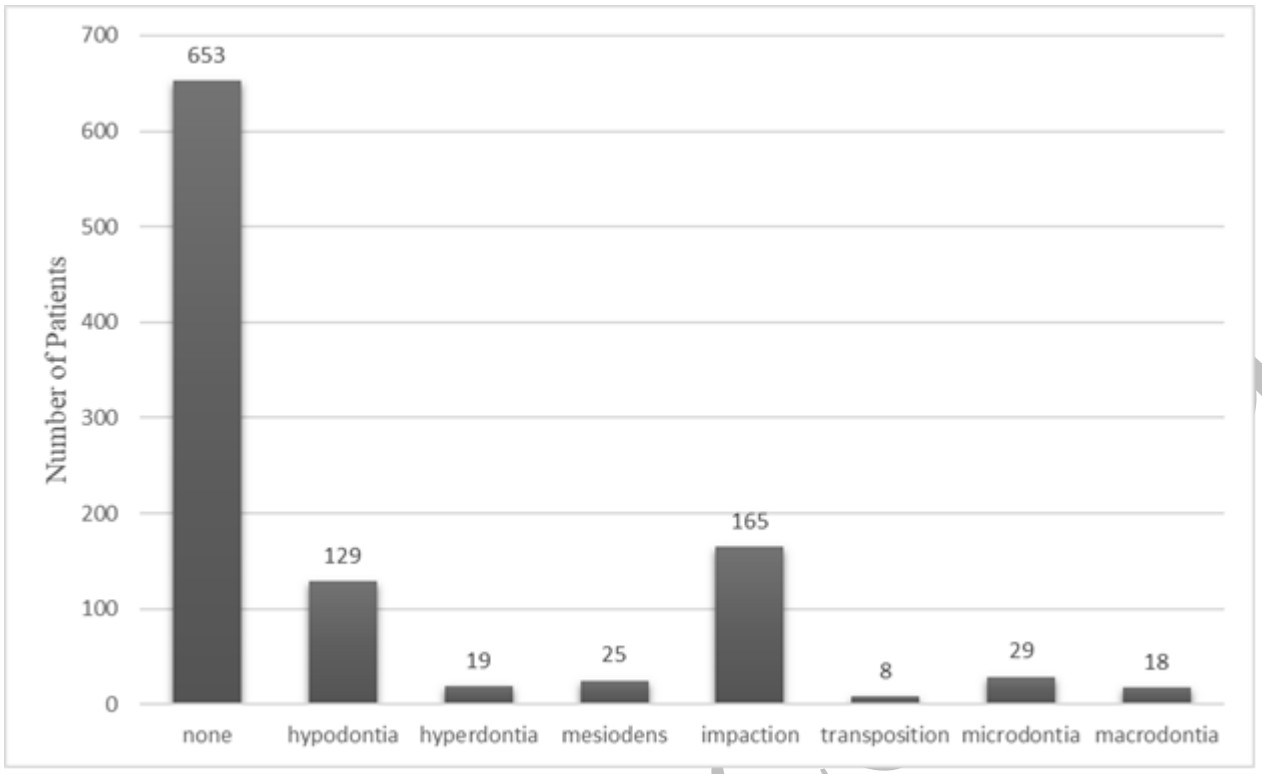

Figure 2. Number of male and female patients with anomalies of tooth number

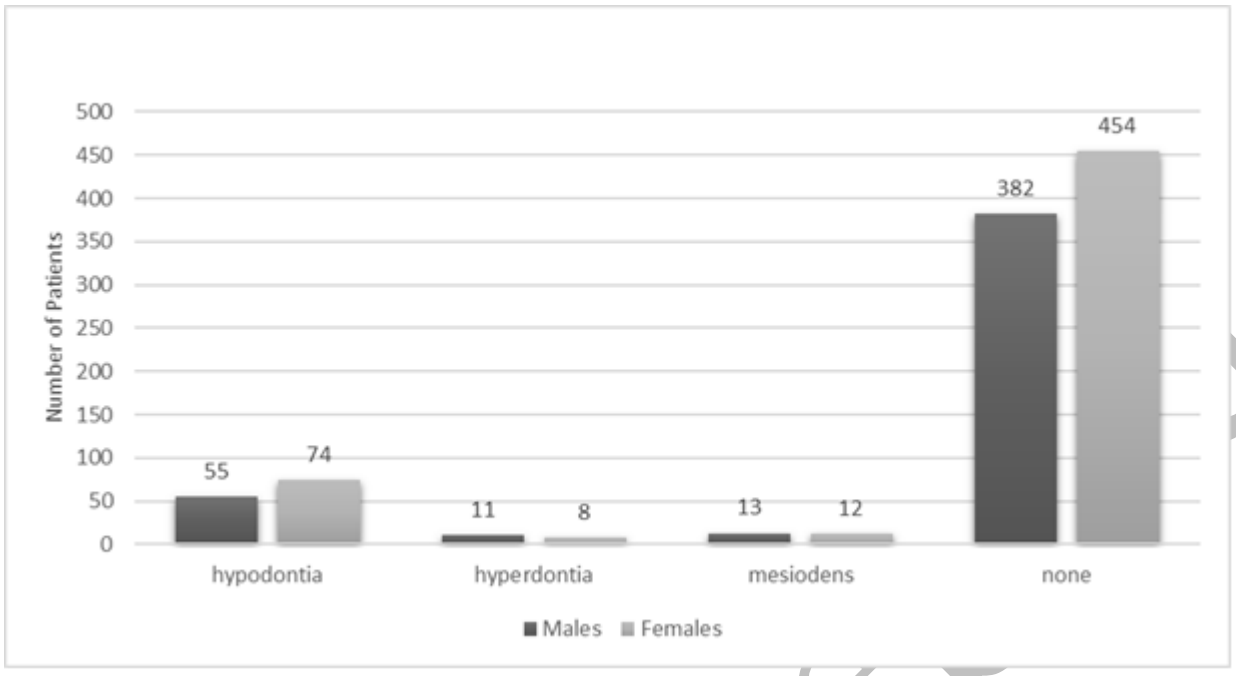

Figure 3. Number of male and female patients with anomalies of tooth position

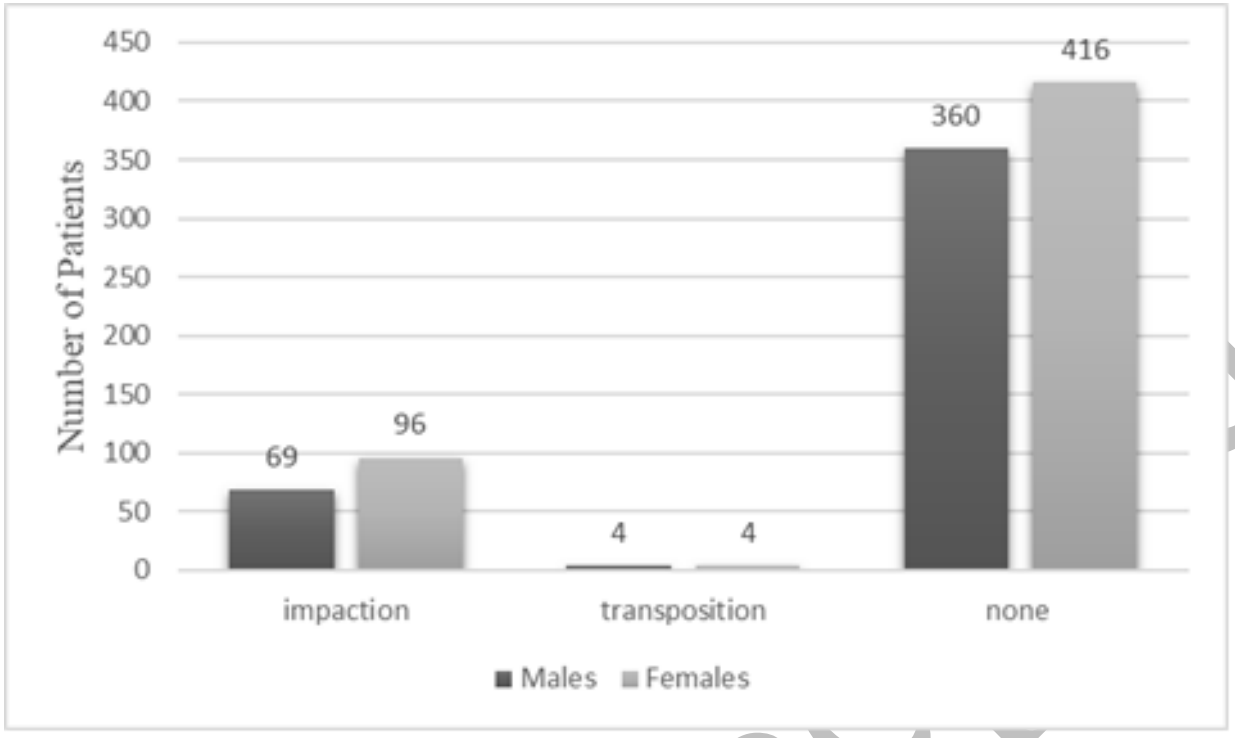

Figure 4. Number of male and female patients with anomalies of tooth size

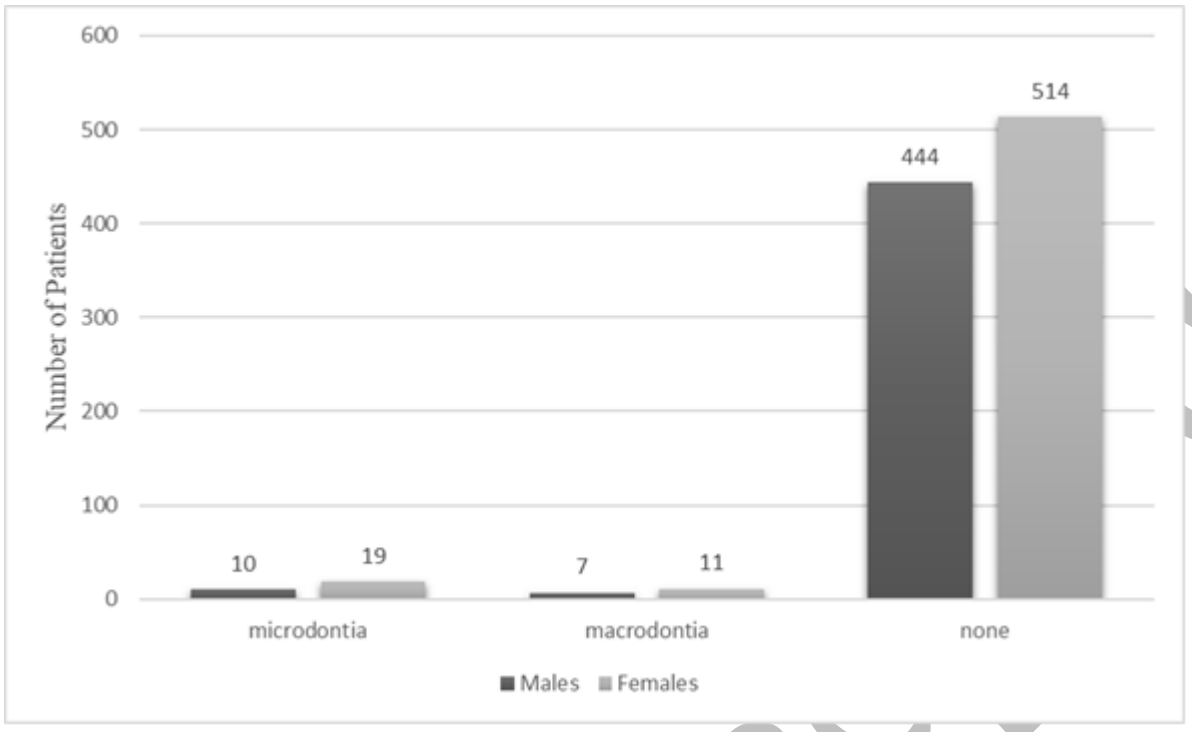

Table 1. Location and prevalence of maxillary teeth affected by developmental dental anomalies. Comparison between males and females. χ^2 test and Fisher's exact test ($p < 0.05$)

Tooth	Sex	Hypodontia		Hyperdontia		p value	Impaction		Transposition		p value	Microdontia		Macrodontia		p value
		n	(%)	n	(%)		n	(%)	n	(%)		n	(%)	n	(%)	
17	M	6	1.3	/		0.153	0	0	/		0.005*	/		/		/
	F	2	0.4				9	1.7								
16	M	/		/		/	/		/		/	/		/		/
	F															
15	M	21	4.6	3	0.7	0.332	6	1.6	/		0.796	/		/		/
	F	16	3	2	0.4		9	1.7								
14	M	1	0.2	/		0.382	/		1	0.2	1.000	/		/		/
	F	1	0.2						1	0.2						
13	M	1	0.2	/		1.000	25	5.5	1	0.2	0.658	/		/		/
	F	1	0.2				33	6.1	1	0.2						
12	M	8	1.7	3	0.7	0.549	1	0.2	/		1.000	6	1.3	1	0.2	0.873
	F	15	2.8	3	0.6		1	0.2				6	1.1	2	0.4	
11	M	0	0	/		1.000	10	2.2	/		0.477	/		2	0.4	0.120
	F	1	0.2				8	1.5						8	1.5	
21	M	0	0	/		0.256	6	1.3	/		0.526	/		4	0.9	0.761
	F	3	0.6				4	0.7						6	1.1	
22	M	7	1.5	3	0.7	0.468	2	0.4	/		0.209	7	1.5	1	0.2	0.310
	F	10	1.8	1	0.2		0	0				13	2.4	4	0.7	
23	M	3	0.7	/		1.000	22	4.8	2	0.4	0.894	/		/		/
	F	3	0.6				27	5	1	0.2						
24	M	1	0.2	/		1.000	/		2	0.4	1.000	/		/		/
	F	2	0.4						3	0.6						
25	M	19	4.1	1	0.2	0.571	6	1.3	/		1.000	/		/		/
	F	27	5	3	0.5		7	1.4								
26	M	/		/		/	/		/		1.000	/		/		/
	F															
27	M	5	1.1	/		0.257	0	0	/		0.256	/		/		/
	F	2	0.4				3	0.6								

* statistically significant; [a] χ^2 test; M – males ; F – females; n – number; % – percentages

Table 2. Location and prevalence of mandibular teeth affected by developmental dental anomalies. Comparison between males and females. χ^2 test and Fisher's exact test ($p < 0.05$)

Tooth	Sex	Hypodontia		Hyperdontia		p value	Impaction		Transposition		p value	Microdontia		Macrodontia		p value
		n	(%)	n	(%)		n	(%)	n	(%)		n	(%)	n	(%)	
37	M F	8 4	1.7 0.7	/		0.153	4 7	0.9 1.3	/		0.538	/		/		/
36	M F	/		/		/	/		/		/	/		/		/
35	M F	21 16	4.6 3	3 2	0.7 0.4	0.332	6 9	1.3 1.7	/		0.796	/		/		/
34	M F	/		/		/	/		1 0	0.2 0	0.457	/		/		/
33	M F	/		/		/	4 2	0.9 0.4	1 0	0.2 0	0.517	/		/		/
32	M F	2 1	0.4 0.2	/		0.596	/		/		1.000	6 6	1.3 1.1	1 2	0.2 0.4	0.873
31	M F	6 3	1.3 0.6	0 1	0 0.2	0.297	/		/		/	0 1	0 0.2	/		1.000
41	M F	2 3	0.4 0.6	1 0	0.2 0	0.539	/		/		/	0 1	0 0.2	/		1.000
42	M F	3 1	0.7 0.2	0 1	0 0.2	0.330	/		/		/	/		/		/
43	M F	/		/		/	2 3	0.4 0.6	/		0.535	/		/		/
44	M F	/		/		/	/		/		/	/		/		/
45	M F	18 14	3.9 2.6	1 0	0.2 0	0.268	6 7	1.3 1.4	/		1.000	/		/		/
46	M F	/		/		/	/		/		1.000	/		/		/
47	M F	6 4	1.3 0.7	/		0.536	5 7	1.1 1.3	/		1.000	/		/		/

M – males; F – females; n – number; % – percentages

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