Prevalence of Dental Anomalies Assessed Using Panoramic Radiographs in a Sample of the Turkish Population

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Objective: *To determine the prevalence, frequency and distribution of dental anomalies that were detectable on panoramic radiographs in a large sample Turkish population, and the associations among the anomalies.*
Methods: *This study was conducted retrospectively on panoramic radiographs of 43,880 patients who were admitted to the Faculty of Dentistry at Trakya University, Edirne, Turkey. Patients' files were examined by two observers and radiographic images of 2265 patients with at least one dental anomaly were included. Dental anomalies were classified as anomalies in the number, structure, position and shape of teeth. The interactions between the groups were analysed using chi-square tests.*
Results: *The study group consisted of 1336 women (59%) and 929 men (41%) with a mean age of 33.3 ± 14.4 years. A total of 2265 patients, with a prevalence of 5.2% (2265/43880), had at least one dental anomaly. The most frequent anomalies were in position (2.7%) and number (2.1%). Structure anomalies were least common, affecting 0.02% of patients. Among the study group of patients with dental anomalies, 12.2% presented more than one kind of anomaly.*
Conclusion: *Position anomalies were the most common dental anomaly, whereas structural anomalies were least common in a Turkish sample. The prevalence of anomalies varies between populations, confirming the role of racial factors.*

Key words: *fused teeth, impacted tooth, panoramic radiography, supernumerary tooth, tooth abnormalities.*
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Dental anomalies are defined as deviations from the expected number, shape, position and structure of teeth, and can be congenital, developmental or acquired. Congenital types are inherited and have a genetic basis, developmental types occur at the tooth formation stage, and acquired anomalies occur after tooth development[1]. Anomalies in number, morphology and size are included in developmental anomalies while eruption anomalies that may occur due to early loss of deciduous tooth can be considered as acquired anomalies[2].

Dental anomalies may occur due to various factors, which are generally expressed as genetic, epigenetic and environmental[3]. Complex interactions between these factors during dental development can lead to abnormal changes, which in turn cause dental anomalies. It has been stated that genetic factors such as multifactorial inheritance and environmental factors such as trauma, radiation, infection and hormonal factors may play a significant role in the formation of dental anomalies[4].

Dental anomalies can be seen in simple isolated defects or symptoms of specific syndromes and can result in various problems. While developmental anomalies of enamel can cause problems such as tooth sensitivity and susceptibility to caries, situations such as impacted, supernumerary and missing teeth may lead

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to orthodontic problems by affecting occlusion[5]. These problems, especially those related to the anterior region, may cause aesthetic issues and also lead to psychological problems[6].

Detailed investigation of dental anomalies is essential to prevent further complications such as malocclusion, aesthetic deformities, periodontal problems, caries lesions and difficulties during extraction and root canal treatment[7]. Thus, radiographic observations play an important role in the differential diagnoses of anomalies as well as clinical examinations. Panoramic radiographs are frequently used in oral examination for diagnostic purposes and can also be used to diagnose dental anomalies[8]. Radiographic evaluation is the most effective method to detect many different anomalies that cannot be noticed only through clinical examination.

Many studies have examined the prevalence of dental anomalies, but the results show inconsistencies for different populations[9-12]. Incidence and degree of expression of dental anomalies in different population groups can provide important information for phylogenic and genetic studies and may assist understanding of variations within and between the different populations[13]. Thus, population-specific prevalence studies are required to provide physicians with information about anomalies that can affect oral health and thereby quality of life. Studies with a large sample size make it possible to detect the rarest types as well as variable types in a specific population in terms of genetic predisposition. Early diagnosis can therefore guide effective management of personal preventive dentistry and dental treatment programmes.

The present study aims to determine the frequency and distribution of dental anomalies that are detectable on panoramic radiographs in a large sample of the Turkish population, and the associations among them.

Materials and methods

The ethical permissions necessary for this study were obtained from the Scientific Research Ethics Committee of Trakya University, Edirne, Turkey (TÜTF-BAEK 2020/243). This cross-sectional study was planned retrospectively on routine panoramic radiographs of 43,880 patients who were admitted to the Faculty of Dentistry at the university between 2015 and 2020. The files of 43,880 patients were examined by two observers, and panoramic radiographs of 2265 patients aged between 12 and 60 years and with at least one dental anomaly who met the inclusion criteria were included. The radiographs examined in this study were taken with the same panoramic radiograph device (PaX-Flex3D, Vatech, Hwaseong, South Korea) at the Department of Radiology at Trakya University. None of the radiographs were exposed specifically for this study.

After examining the anamnesis in the patient files, individuals with systemic diseases, syndromes, tooth extraction due to caries lesions, trauma or orthodontic reasons, large restorations that prevent the observation of crown morphology and insufficient radiograph quality for optimal evaluation that could negatively affect the study were excluded. In addition, third molars, due to their wide morphology and position variations, were also excluded.

The radiographic images were evaluated independently by two different observers on the computer monitor with subdued ambient lighting and anomalies were classified as number (including hypodontia, oligodontia and hyperdontia), structure (including amelogenesis imperfecta, dentinogenesis imperfecta, dentine dysplasia and regional odontodysplasia), position (including transposition, ectopia, impaction and inversion) and shape (including microdontia, macrodontia, fusion, talon cusp, dens invaginatus and taurodontism).

To estimate the reproducibility of the diagnosis, 100 randomly selected radiographs were examined separately by two observers once again and the interobserver agreement was determined. Parameters such as patients' age, sex, type and region of dental anomalies were recorded.

Statistical analysis was performed using SPSS Statistics for Windows, version 23.0 (IBM, Armonk, NY, USA). Descriptive statistics such as frequency distributions and percentages were calculated for the categorical data. Chi-square and Fisher exact tests were used to determine potential differences in the distribution of dental anomalies stratified by sex and age variables and to determine the interaction between different dental anomalies. The correlation coefficient was also used to evaluate the relationship between the number of detected dental anomalies and age. A Cohen kappa statistic was used between the two observers to test the reproducibility of the diagnosis. The level of significance was set at $P < 0.05$ was considered significant.

Results

The distributions of different types and subtypes of dental anomalies are shown in Table 1. The Cohen kappa analysis demonstrated substantial interexaminer agreement (Kappa 0.892). Of the 43,880 panoramic radiographs, 2265 patients had at least one dental anomaly, with a prevalence rate of 5.2%. The study group of patients with dental anomalies consisted of 1336 women (59%) and 929 men (41%) with a mean age of 33.3 ± 14.4 ears.

Table 1 Distribution of different dental anomalies and subtypes.

Type and subtypes of anomalies			Frequency, n (%)	Prevalence, %
Number	Hypodontia	Total	655 (29.0)	1.5
		Missing central incisor	18 (0.9)	0.04
		Missing lateral incisor	307 (13.5)	0.7
		Missing canine	91 (4)	0.2
		Missing premolar	239 (10.6)	0.5
		Missing molar	0 (0.0)	0.0
	Oligodontia		18 (0.9)	0.04
	Hyperdontia	Total	254 (11.0)	0.6
		Supernumerary central incisior	8 (0.4)	0.02
		Supernumerary lateral incisor	14 (0.6)	0.03
		Supernumerary canine	10 (0.4)	0.02
		Supernumerary premolar	82 (3.6)	0.2
		Supernumerary molar	0 (0.0)	0.0
		Mesiodens	54 (2.4)	0.1
		Paramolar	86 (3.8)	0.2
	Total		927 (41.1)	2.1
Position	Transposition		13 (0.6)	0.03
	Ectopia		62 (2.7)	0.1
	Impaction	Total	1077 (47.6)	2.5
		Impacted central incisor	15 (0.7)	0.03
		Impacted lateral incisor	8 (0.4)	0.02
		Impacted canine	853 (37.7)	1.9
		Impacted premolar	130 (5.7)	0.3
		Impacted molar	71 (3.1)	0.2
	Inversion		20 (0.9)	0.05
	Total		1172 (51.8)	2.7
Shape	Microdontia		404 (17.8)	0.9
	Macrodontia		2 (0.1)	0.004
	Fusion-gemination		2 (0.09)	0.004
	Talon cusp		14 (0.6)	0.03
	Dens invaginatus		8 (0.4)	0.02
	Taurodontism		48 (2.1)	0.1
	Total		478 (21.1)	1.1
Structure	Amelogenesis imperfecta		8 (0.4)	0.02
Total			2265 (100.0)	5.2

The most frequent anomalies were impacted teeth (2.5%), hypodontia (1.5%) and microdontia (0.9%). Structural anomalies, affecting 0.02% of patients, were the least common anomaly observed, followed by shape anomalies (1.1%). Among the study group patients, 12.2% presented more than one dental anomaly. A negative correlation was observed between age and the number of anomalies (r = −0,061, $P = 0.004$). As patients got older, the number of anomalies encountered decreased. The occurrence of dental anomalies was statistically significantly higher in women ($P = 0.00$).

The occurrence of missing central incisors was statistically significantly higher in the mandible than the maxilla ($P = 0.01$) and occurred bilaterally ($P = 0.00$). The most common anomaly relating to number was missing lateral incisors (0.7%) and presented statistically significantly frequently in the maxilla ($P = 0.00$). In contrast to missing premolars, missing canines were found to occur statistically significantly more frequently in the maxilla (P = 0.00). No cases of agenesis of the maxillary or mandibular first molars were observed. Supernumerary central and lateral incisors were all located in the maxilla. Although the frequency of supernumerary canines in the maxilla and mandible were similar, supernumerary premolars were significantly more common in the mandible ($P = 0.00$). While mesiodens was statistically significantly higher in women ($P = 0.005$), there was no correlation between paramolar presence and sex.

Fig 1 Radiograph of a case displaying kissing molars.

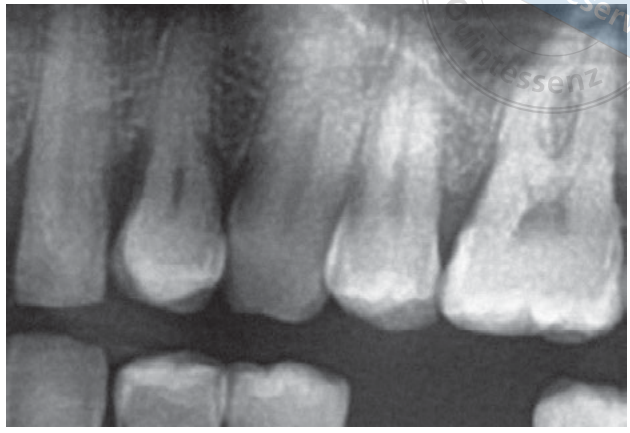

Fig 3 Radiograph of a case involving complete transposition of the upper left permanent canine and premolar.

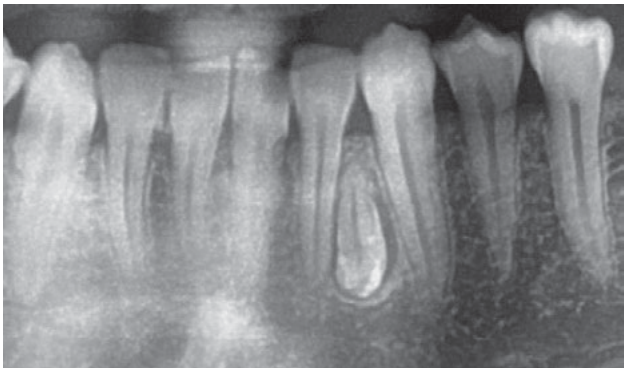

Fig 2 Representative radiograph of a supernumerary mandibular microdontic canine with inversion.

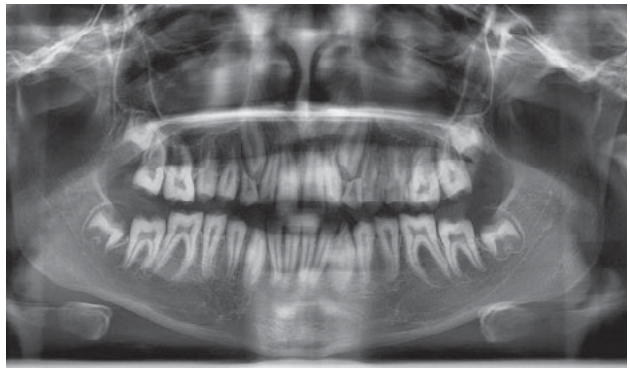

Fig 4 Panoramic radiograph of a case displaying amelogenesis imperfecta. Note the generalised crown abnormalities, such as flat occlusal surfaces and the presence of hypoplastic enamel with more radiodensity in contrast to dentine.

Impacted canines were the most common positional anomaly (1.9%) and the maxilla was more often affected than the mandible ($P = 0.00$). The incidence of impaction was rather unilateral ($P = 0.00$); both the right and left sides were affected similarly. On the other hand, impacted premolars were often present in the mandible ($P = 0.00$).

Only five patients (0.005%) presented kissing molar teeth (Fig 1). No statistically significant correlation was detected between inversion (Fig 2), transposition (Fig 3) and sex ($P = 0.147$ and $P = 0.111$, respectively). A positive correlation was detected between inversion and ectopia ($P = 0.016$).

The most common shape anomaly was microdontia (0.9%) and 86.4% of microdontia cases involved the maxillary lateral incisors and were significantly higher in women ($P = 0.00$). Only two patients exhibited macrodontia (0.004%), and all were in mandibular molars.

The most common shape anomaly following microdontia was taurodontism (0.1%). The distribution of taurodontism was similar between arches and all cases were in molars. Fourteen patients (0.03%) had talon cusps and all were in the maxillary lateral incisors. Similarly, all cases exhibiting dens invaginatus were in maxillary lateral incisors. No statistically significant correlation was found between the occurrence of talon cusps, taurodontism, dens invaginatus and sex ($P = 0.454$, $P = 0.063$ and $P = 0.993$, respectively).

Eight patients with evident amelogenesis imperfecta (0.02%) (Fig 4) were detected. No cases of dentinogenesis imperfecta, dentin dysplasia or regional odontodysplasia were observed.

Discussion

The present study investigated the prevalence and association between different dental anomalies in a large sample. Due to the differences in the reported prevalence of anomalies in various racial and ethnic groups, the authors planned to investigate the frequencies

in a sample of Turkish patients in the Thrace region. Although there have been several studies investigating the prevalence of various dental anomalies[10,13-15], only a few studies considered all types and subtypes of dental anomalies, and none have been conducted with such a large randomised sample group.

It has been reported in various studies that the prevalence of dental anomalies is between 1.73% and 74%[1,5,16]. The highest prevalence in the literature was 74.78% as reported by Tongudomporn and Freer[17] and this finding, which was higher than those of previous random sample studies, was explained as a result of orthodontic patients' tendency to have more dental anomalies than the general population. In non-orthodontic patient groups, the prevalence of dental anomalies was reported to be 40.8% by Ezoddini et al[18] in 2007, 34.28% by Gupta et al[19] in 2011, 29% by Shokri et al[20] in 2014, 4.75% by Aren et al[12] in 2015 and 1.8% by Almaz et al[3] in 2017. These conflicting results can be explained primarily by racial differences and sampling techniques, and also by local environmental influences and nutrition. Additionally, with the exception of the differences in the sampled population, other influential factors are the diagnostic methods and the criteria used in the studies. In the present study, the prevalence of dental anomalies diagnosed by panoramic radiographs was approximately 5.2%. This result was consistent with the prevalence rate of 5.46% reported by Altuğ-Atac and Erdem[15]. The fact that the prevalence rates were almost equal indicates that the results of studies conducted in the same ethnic groups will be similar even if the sample groups are different.

Diagnostic methods could affect study results. Developmental dental anomalies can be diagnosed clinically as well as radiographically. When clinical examination and radiographic examination were performed together, as in the study by Gupta et al[19], a higher prevalence rate (34.28%) than in the present study was reported; however, many studies in the literature have shown that most anomalies can be detected by careful radiographic examination[8,18,19]. In addition, a larger sample group can be reached by examining routine panoramic radiographs, and more reliable results can be obtained with a larger sample. Thus, in the present study, anomalies were evaluated by using panoramic radiographs, as in most studies in the literature.

The inclusion of third molars may also increase the prevalence of anomalies. The prevalence was reported to be 36.7% by Patil et al[13] and 45.1% by Afify and Zawawi[21] when third molars were included. Since third molars show more variations than other teeth, the prevalence of anomalies was reported to be higher when they were included. Consequently, third molars were not included in the present study in order not to affect the results.

Studies investigating types and prevalence of dental anomalies reported that the most common anomaly types were position and number[7,13,22], corresponding to the results of this study. In the present study, 12.2% of the study group presented more than one dental anomaly, similar to the rate of 10% reported by Bilge et al[1]; however, these values were lower than the 21.27% reported by Shokri et al[20].

Several studies indicated that dental anomalies were statistically independent of sex[10,14,19]. In contrast, the present study found that women were statistically significantly more prone to exhibiting dental anomalies, as in a study by Pallikaraki et al[22]. Similarly, reports suggest that women display a higher incidence of dental agenesis[23,24].

In the present study, the prevalence of anomalies in terms of number was 2.1%, and the most common of these was hypodontia (1.5%). The reported prevalence of congenitally missing third molars varies between 5% and 37%[25]. When third molars are excluded, the prevalence ranges between 0.15% and 16.2%[25-27]. In line with the results of the present study, it has been reported that in many populations, the most frequently missing teeth, with the exception of the third molars, are the maxillary lateral incisors and mandibular premolars[26]. It is believed that the reduction in the number of teeth and the size of the jaw are part of human evolution and will continue and become more frequent in years to come[19].

In previous studies, it was reported that the prevalence of supernumerary teeth ranges from 0.1% to 3%[8,15]. Similarly, the prevalence reported in the present study was 0.6%. Supernumerary teeth affect the maxilla more than the mandible (8:1)[28], as in the present study. In previous studies, the majority of detected supernumerary teeth were mesiodens[22,29]. Cases involving supernumerary teeth most commonly affect the anterior maxilla, followed by the mandibular premolar region[30]; however, the most common supernumerary teeth in the present study were paramolars (0.2%) and supernumerary premolars (0.2%), followed by mesiodens (0.1%). This suggests that supernumerary teeth may not be depicted clearly in panoramic radiographs due to the narrow focal trough in the anterior maxilla[31].

Transposition is a rare position anomaly that involves the permanent dentition (prevalence 0.3% to 0.4%) and is more frequently seen in the maxilla[32]. In the present study, the prevalence of transpositions was 0.03% and even although it was more commonly detected in the

maxilla, there was no significant difference between the arches. Transposition is commonly encountered with other anomalies, such as aplasia and peg-shaped lateral incisors[33]; however, no relationship was observed in the present study. It has been reported that transposition usually involves the canines, along with either the incisors or premolars[34]. Likewise, in the present study, the canines were involved in most cases. There was also a significant relationship between impacted canines and transposition ($P = 0.000$). Canines affected by transposition tended to remain impacted.

The prevalence of ectopic eruption has been reported to range from 0.01% to 8.9%[7,19,21]. In the present study, the prevalence was determined to be 0.1%, which was in accordance with the findings of Uslu et al[14] and Afify et al[21]. On the other hand, the prevalence of ectopic eruption was considerably lower compared to other studies[19,35]. Although it has been reported in the literature that transpositions constitute a significant part of ectopia, no correlation was found between transposition and ectopia in the present study; however, there was a significant relationship between ectopia and inversion. Inverted teeth were commonly in ectopic positions.

The prevalence of impacted teeth was 2.5%, which was much lower than in the study of Pallikaraki et al[22] who reported a prevalence of 5.4% in Greece. Maxillary canines were found to be the most impacted tooth excluding third molars, supporting previous findings[14,19,22]. It is not surprising that canines, the last erupted teeth in the arches, are most frequently remain impacted due to a lack of space.

Concerning shape anomalies, macrodontia was reported to be less common than microdontia in previous studies[15-22]. Likewise, only two cases of macrodontia were detected in the present study (0.004%), and all were in mandibular molars. The prevalence of microdontia reported in the current study (0.9%) was similar to that reported by Uslu et al[14] (0.7%) and Patil et al[13] (1.0%). However, other authors reported higher prevalence rates of microdontia due to the inclusion of third molars. Consistent with studies in the literature[13,15], the maxillary lateral incisors were the teeth most affected by microdontia in the present study.

The association between the unilateral agenesis of the maxillary lateral incisor and the microdontia of the contralateral incisor is often observed clinically, and a statistically significant relationship was detected in the present study ($P = 0.000$). This situation was explained by the fact that the genetic defect that determined the agenesis had an incomplete expression on the opposite side of the dental arch, causing microdontia[21].

Only a few studies have reported the prevalence of taurodontism, which varies between 0.02% and 46.4%12,[19]. Diagnosis of taurodontism can be difficult in permanent teeth with ongoing root development, and consequently, it has been reported that the prevalence of taurodontism is lower in people aged under 20 years. The prevalence of taurodontism was 0.1% in the present study which was lower than that reported by Pillai et al[36] (4.79%). On the other hand, the reported prevalence in the present study was higher than in the study by Laganà et al[5].

In the literature, it was reported that the prevalence of fusion ranges from 0.0% to 0.8%[1,7]. Similarly, the prevalence of fusion, which affected both sexes equally ($P = 0.652$), was 0.004% in the present study. The prevalence of talon cusps ranges from 1% to 8% in permanent teeth, with a higher frequency in men than women[37]. However, the prevalence was 0.03% in the present study and they were more predominant in maxillary lateral incisors, which is consistent with results reported by Dash et al[37]. Dens invaginatus was also a rare dental anomaly. Despite the reported prevalence ranging from 0.47% to 6.7%[10], it was found to be lower (0.02%) in the present study.

Structural anomalies are reported to be very rare, with a prevalence less than 5/1000[38]. In fact, structural anomalies may be difficult to detect on radiographs and without a clinical observation (mostly in their less severe forms). Nevertheless, eight prominent cases of generalised amelogenesis imperfecta (0.02%) were identified in the present study. Dentinogenesis imperfecta, dentine dysplasia and regional odontodysplasia were not observed, which is not surprising considering the rarity of these anomalies.

Within the limitations of this study, treated anomalies could not be detected; thus, prevalence may be higher than reported. On the other hand, the lack of clinical examination was another limitation of the study. A prospective study with clinical examination would have allowed precise detection of dental anomalies and improved the sensitivity of the study, especially for the detection of structural and positional anomalies.

Conclusion

The prevalence and type of dental anomalies seemingly vary within and between populations, confirming the role played by racial factors. Genetic differences and the diagnostic criteria used may have led to differences between studies. Although the prevalence of dental anomalies varies within and between populations, the results of the present study were consistent with those of previous studies conducted into the same race.

Early diagnosis and timely management of dental anomalies can prevent further complications. It is therefore crucial to perform a careful radiographic examination in addition to the clinical examination. Population-specific studies will help clinicians to recognise the most common types of anomaly encountered in that region and enable patients to be informed about the effect and prognosis of dental anomalies as well as the treatment plan.

Conflicts of interest

The authors declare no conflicts of interest related to this study.

Author contribution

Dr Mediha Büyükgöze-Dindar contributed to the conceptualisation, methodology, data curation, formal analysis and draft preparation; Dr Meltem Tekbas-Atay contibuted to the conceptualisation, methodology, investigation, writing, review and editing of the manuscript.

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References

1. Bilge NH, Yeşiltepe S, Törenek Ağırman K, Çağlayan F, Bilge OM. Investigation of prevalence of dental anomalies by using digital panoramic radiographs. Folia Morphol (Warsz) 2018;77:323–328.
2. Celebi F, Taşkan MM, Turkal M. Dental anomaly prevalence in middle black sea population. Cumhuriyet Dent J 2015;18:343–350.
3. Almaz ME, Sönmez IS, Oba AA. Prevalence and distribution of developmental dental anomalies in pediatric patients. Meandros Med Dent J 2017;18:130–133.
4. Bu X, Khalaf K, Hobson RS. Dental arch dimensions in oligodontia patients. Am J Orthod Dentofacial Orthop 2008;134:768–772.
5. Laganà G, Venza N, Borzabadi-Farahani A, Fabi F, Danesi C, Cozza P. Dental anomalies: Prevalence and associations between them in a large sample of non-orthodontic subjects, a cross-sectional study. BMC Oral Health 2017;17:62.
6. Bassiouny DS, Afify AR, Baeshen HA, Birkhed D, Zawawi KH. Prevalence of maxillary lateral incisor agenesis and associated skeletal characteristics in an orthodontic patient population. Acta Odontol Scand 2016;74:456–459.
7. Yassin SM. Prevalence and distribution of selected dental anomalies among Saudi children in Abha, Saudi Arabia. J Clin Exp Dent 2016;8:e485–e490.
8. Anthonappa RP, King NM, Rabie AB, Mallineni SK. Reliability of panoramic radiographs for identifying supernumerary teeth in children. Int J Paediatr Dent 2012;22:37–43.
9. Dang HQ, Constantine S, Anderson PJ. The prevalence of dental anomalies in an Australian population. Aust Dent J 2017;62:161–164.
10. Baron C, Houchmand-Cuny M, Enkel B, Lopez-Cazaux S. Prevalence of dental anomalies in French orthodontic patients: A retrospective study. Arch Pediatr 2018;25:426–430.
11. Shilpa G, Gokhale N, Mallineni SK, Nuvvula S. Prevalence of dental anomalies in deciduous dentition and its association with succedaneous dentition: A cross-sectional study of 4180 South Indian children. J Indian Soc Pedod Prev Dent 2017;35:56–62.
12. Aren G, Guven Y, Guney Tolgay C, et al. The prevalence of dental anomalies in a Turkish population. J Istanb Univ Fac Dent 2015;49:23–28.
13. Patil SR, Maragathavalli G, Araki K, et al. Three-rooted mandibular first molars in a Saudi Arabian population: A CBCT study. Pesqui Bras Odontopediatria Clin Integr 2018;18:e4133.
14. Uslu O, Akcam MO, Evirgen S, Cebeci I. Prevalence of dental anomalies in various malocclusions. Am J Orthod Dentofacial Orthop 2009;135:328–335.
15. Altug-Atac AT, Erdem D. Prevalence and distribution of dental anomalies in orthodontic patients. Am J Orthod Dentofacial Orthop 2007;131:510–514.
16. Herrera-Atoche JR, Agüayo-de-Pau MD, Escoffié-Ramírez M, Aguilar-Ayala FJ, Carrillo-Ávila BA, Rejón-Peraza ME. Impacted maxillary canine prevalence and its association with other dental anomalies in a Mexican population. Int J Dent 2017;2017:7326061.
17. Thongudomporn U, Freer TJ. Prevalence of dental anomalies in orthodontic patients. Aust Dent J 1998;43:395–398.
18. Ezoddini AF, Sheikhha MH, Ahmadi H. Prevalence of dental developmental anomalies: A radiographic study. Community Dent Health 2007;24:140–144.
19. Gupta SK, Saxena P, Jain S, Jain D. Prevalence and distribution of selected developmental dental anomalies in an Indian population. J Oral Sci 2011;53:231–238.
20. Shokri A, Poorolajal J, Khajeh S, Faramarzi F, Kahnamoui HM. Prevalence of dental anomalies among 7- to 35-year-old people in Hamadan, Iran in 2012-2013 as observed using panoramic radiographs. Imaging Sci Dent 2014;44:7–13.
21. Afify AR, Zawawi KH. The prevalence of dental anomalies in the Western region of Saudi Arabia. ISRN Dent 2012;2012:837270.
22. Pallikaraki G, Sifakakis I, Gizani S, Makou M, Mitsea A. Developmental dental anomalies assessed by panoramic radiographs in a Greek orthodontic population sample. Eur Arch Paediatr Dent 2020;21:223–228.
23. Vastardis H. The genetics of human tooth agenesis: New discoveries for understanding dental anomalies. Am J Orthod Dentofacial Orthop 2000;117:650–656.
24. Muller TP, Hill IN, Peterson AC, Blayney JR. A survey of congenitally missing permanent teeth. J Am Dent Assoc 1970;81:101–107.
25. Rakhshan V. Congenitally missing teeth (hypodontia): A review of the literature concerning the etiology, prevalence, risk factors, patterns and treatment. Dent Res J (Isfahan) 2015;12:1–13.
26. Fekonja A. Hypodontia in orthodontically treated children. Eur J Orthod 2005;27:457–460.
27. De Coster PJ, Marks LA, Martens LC, Huysseune A. Dental agenesis: Genetic and clinical perspectives. J Oral Pathol Med 2009;38:1–17.
28. Subasioglu A, Savas S, Kucukyilmaz E, Kesim S, Yagci A, Dundar M. Genetic background of supernumerary teeth. Eur J Dent 2015;9:153–158.
29. Hurlen B, Humerfelt D. Characteristics of premaxillary hyperodontia. A radiographic study. Acta Odontol Scand 1985;43:75–81.
30. Shah A, Gill DS, Tredwin C, Naini FB. Diagnosis and management of supernumerary teeth. Dent Update 2008;35:510–512, 514–516, 519–520.
31. Witcher TP, Brand S, Gwilliam JR, McDonald F. Assessment of the anterior maxilla in orthodontic patients using upper anterior occlusal radiographs and dental panoramic tomography: A comparison. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:765–774.
32. Yilmaz HH, Türkkahraman H, Sayin MO. Prevalence of tooth transpositions and associated dental anomalies in a Turkish population. Dentomaxillofac Radiol 2005;34:32–35.

33. Ely NJ, Sherriff M, Cobourne MT. Dental transposition as a disorder of genetic origin. Eur J Orthod 2006;28:145–151.
34. Peck L, Peck S, Attia Y. Maxillary canine-first premolar transposition, associated dental anomalies and genetic basis. Angle Orthod 1993;63:99–109; discussion 110.
35. Vani NV, Saleh SM, Tubaigy FM, Idris A. Prevalence of developmental dental anomalies among adult population of Jazan, Saudi Arabia. Saudi J Dent Res 2016;7:29–33.
36. Pillai KG, Scipio JE, Nayar K, Louis N. Prevalence of taurodontism in premolars among patients at a tertiary care institution in Trinidad. West Indian Med J 2007;56:368–371.
37. Dash JK, Sahoo PK, Das SN. Talon cusp associated with other dental anomalies: A case report. Int J Paediatr Dent 2004;14:295–300.
38. Gadhia K, McDonald S, Arkutu N, Malik K. Amelogenesis imperfecta: An introduction. Br Dent J 2012;212:377–379.