Journal of
Oral Health and Oral Epidemiology

https://johoe.kmu.ac.ir
10.34172/johoe.2023.31
Vol. 12, No. 4, 2023, 183-188

Original Article

Evaluation of dental anomaly prevalence and types by cone beam computed tomography in a subgroup of Turkish population

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Abstract

Background: This study aimed to investigate the frequency and variation of dental malformations in a subgroup of the Turkish population.

Methods: Cone beam computed tomography (CBCT) images taken for various reasons were scanned retrospectively. The presence of dental anomaly, type of dental anomaly, subtype of dental anomaly, occurrence of pathology due to the dental anomaly, and type of pathology were recorded. Dental anomalies were divided into five subgroups, including anomalies in shape, number, structure, position, and size. Data analysis was performed with SPSS, and statistical significance was defined as a *P* value below 0.05.

Results: The study utilized a dataset of 1942 images for analysis. Four hundred thirty-five dental anomalies were detected in 414 patients (21.3%), with at least one dental anomaly in each patient. The most common anomaly type was position anomalies (n = 271, 62.3%), and the least observed anomaly type was structural anomalies (n = 3, 0.7%). The most common dental anomaly subtype was impacted teeth (n = 214, 49.2%), and the least common were odontodysplasia, fusion/gemination, and accessory root (n = 1, 0.2%). Pathology due to dental anomaly was detected in 26 patients (6%), and the most common pathology was cystic lesion formation (n = 13, 3%).

Conclusion: The prevalence and types of dental anomalies may differ between and within populations. The prevalence of dental anomaly was 21.3% in this study, and the most common type was position anomaly.

Keywords: Anomaly, Cone beam computed tomography, Pathology, Prevalence

Citation: Şendişçi Gök, Tercanlı Alkış . Evaluation of dental anomaly prevalence and types by cone beam computed tomography in a subgroup of Turkish population. *J Oral Health Oral Epidemiol.* 2023;12(4):183–188. doi: 10.34172/johoe.2023.31

Received: August 26, 2023, **Accepted:** October 30, 2023, **ePublished:** December 29, 2023

Introduction

Changes in the number, size, shape, structure, and eruption of teeth lead to dental anomalies.[1] Dental anomalies arising during the tooth formation process are classified as developmental, while those occurring after tooth maturation are recognized as acquired.[2] Although the etiology of dental anomalies remains unclear, their onset is usually during tooth development with the interaction of genetic, epigenetic, and environmental factors. Anomalies are among the most common dental problems.[3] Teeth with anomalies can prevent normal eruption procedures and cause occlusion and aesthetic problems. In addition, dental anomalies may cause speech and chewing problems, temporomandibular joint pain, and periodontal problems in some patients. Endodontic treatments and tooth extraction procedures for these teeth may be difficult for the physician.[4]

In medical imaging, cone beam computed tomography (CBCT) presents a lower-radiation alternative to computed tomography (CT) while still providing 3D visualization that can view teeth and their supporting structures.[5] As a non-superposition image is obtained with CBCT, the localization of teeth with dental anomalies, pathological conditions in that area, or resorption in neighboring teeth can be seen.[6]

Although there are a few studies on dental anomalies in Turkey,[7,8] to our knowledge, no study has been conducted on dental anomaly types or prevalence in individuals living in the Mediterranean Region.

This study aimed to evaluate the CBCT images of individuals who applied to Akdeniz University Faculty of Dentistry regarding the presence of dental anomalies, type of dental anomalies, subtype of dental anomalies, occurrence of pathology due to the dental anomalies, and type of pathology. As no study was specific to the Mediterranean Region, this research may contribute to the dentists' knowledge of anomaly types in that region and the proper treatment plan for them.

Material and Methods

The Declaration of Helsinki served as the ethical framework for conducting this research. The study

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protocol was reviewed and approved by the Akdeniz University Faculty of Medicine Clinical Research Ethics Committee under the ethical code KAEK-158. Using the reported prevalence of dental anomalies in the study by Bilge et al[9] (39.2%) as a guide, the current study sample size was determined as 1942 patients with 95% confidence and 1% deviation according to the sample size formula with a known population.

Data collection

A retrospective analysis of 1942 CBCT scans was conducted on patients presenting to the Department of Oral and Maxillofacial Radiology, Akdeniz University Faculty of Dentistry, for diverse clinical indications between February 2020 and February 2022 were examined retrospectively. The following exclusion criteria were applied: (1) images of individuals with any disease affecting the craniofacial region, (2) images with suspicion of trauma, (3) images with pathologies caused by developmental, metabolic, or inflammatory factors, (4) images with poor image quality, and (5) images in which the entire maxillofacial region was not in the field of view. In addition, the address information registered in the system was checked to confirm that the patients lived in the Mediterranean Region, and patients who did not live in this region were excluded from the study. Anamnesis and address information for all patients were documented within the Metasoft DentAsist program (version 3.0.448), a software application developed in Eskişehir, Turkey.

Images

Standardized CBCT imaging protocols were established, employing a Veraview X800 CBCT unit (J. Morita Mfg. Corp., Kyoto, Tokyo) operated by an expert X-ray technician. Specific parameters included a 15 × 15 × 14.1 cm field of view, 4.8 mA tube current, 99 kVp peak kilovoltage, and a 35.8-second exposure time, as per manufacturer recommendations. For quantitative and qualitative evaluation of the CBCT scans, i-Dixel software (Version 2.3.6.1, J Morita Mfg. Corp., Kyoto, Japan) was employed. Blinded assessment of all CBCT images was conducted by two independent researchers (Observer 1 and Observer 2) who were experts in dental radiology (an equal number of images for each observer). Visual evaluation of the images was conducted under controlled conditions: the same LED monitor, viewing distance of 40–50 cm, dim ambient lighting, and consistent tonal adjustments. In order to maintain optimal observer focus and minimize the effects of fatigue, a maximum of ten CBCT images were assigned for evaluation per day. If there was disagreement between the researchers, the CBCT image was excluded from the study.

A comprehensive evaluation of all images was conducted to identify potential dental anomalies, type of dental anomaly, subtype of dental anomaly, occurrence of pathology due to the dental anomaly, and type of pathology. Dental anomalies were examined in five subgroups: shape anomaly (taurodontism, dilation, accessory root, fusion/gemination, and dense invaginates), number anomaly (hyperdontia and hypodontia), structural anomaly (odontodysplasia and pre-eruptive intracoronal resorption), position anomaly (impacted tooth, ectopic tooth, inversion, displacement, and infraposition) and size anomaly (microdontia and macrodontia).[9] For size anomalies, easily detectable deviations, and for number anomalies, the age of the patients and the history of the extraction in the archive were taken into account. Classification of structural anomalies was made only based on radiological images. The patient's age and the associated tooth's eruption position were considered for impacted teeth. Teeth with an inverted eruption position were considered "inverse." The teeth that had erupted but had not reached occlusion were considered "infraposition," and the positioning of the teeth outside the dental arch was recorded as "ectopic tooth."

Pathology due to dental anomaly was evaluated as "present" or "absent," and the dental anomaly subtype and type of pathology were recorded. The study protocol included collection of patient demographic data, including the patient's age and gender. Age was divided into < 18 years and ≥ 18 years.

Four weeks later, each observer selected 200 CBCT images randomly from the previously evaluated images and re-examined them, and intra-observer agreement was analyzed. In addition, the observers re-evaluated 200 CBCT images already evaluated by the other observer to test interobserver agreement.

Statistical analysis

A comprehensive statistical analysis was performed using IBM SPSS Statistics (Version 22.0). The Shapiro-Wilk test confirmed the normality of data distribution. Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize the data. The Pearson's chi-square test with a significance threshold of $P < 0.05$ was employed to assess potential differences between groups. The study employed the Kappa coefficient to evaluate both inter-observer and intra-observer agreement, with a standard interpretation adopted: perfect agreement (0.81–1.00) indicating complete consensus between observers, strong agreement (0.61–0.80) reflecting substantial consistency, moderate agreement (0.41–0.60) suggesting some discrepancy, poor agreement (0.10–0.40) denoting minimal concordance, and no agreement (0.00–0.10) signifying no consistency whatsoever.[10]

Results

The intra-observer and inter-observer agreement coefficients are shown in Table 1. Of the 1942 patients, 995 (51.2%) were female and 947 (48.8%) were male, with a mean age of 36.96 ± 16.96 years. Considering age, 304 (15.7%) patients were < 18 years old, and 1638 (84.3%) patients were ≥ 18 years old. A total of 435 dental anomalies were detected, with at least one dental anomaly in 414 (21.3%) patients. There was no statistically significant relationship between dental anomalies and gender ($P = 0.312$), whereas there was a statistically significant relationship between dental anomalies and age ($P < 0.001$).

Position anomalies were the most common type of anomaly (n = 271, 62.3%), and the least observed anomaly type was structural anomalies (n = 3, 0.7%). Table 2 shows the distribution of dental anomaly type by gender and age. The type of dental anomaly did not differ based on gender and age ($P = 0.122$ and $P = 0.744$, respectively).

The most common dental anomaly subtype was impacted teeth (n = 214, 49.2%), and the least common subtypes of dental anomaly were odontodysplasia, fusion/gemination, and accessory root (n = 1, 0.2%). Table 3 shows the distribution of dental anomaly subtypes. Shape anomalies were observed in a total of 115 patients (n = 41, 9.4%); the most common shape anomaly subtype was denned invaginatus (n = 21, 4.8%), and the least common shape anomalies were accessory root and fusion (n = 1, 0.2%, n = 1, 0.2%, respectively). Number anomalies were observed in 115 patients; the most common number anomaly subtype was hypodontia (n = 89, 20.4%). Among the size anomalies, only microdontia was detected (n = 5, 1.1%). Position anomalies were the most common dental anomaly (n = 271, 62.3%). The frequencies of position anomaly subgroups were n = 214 (49.2%), n = 28 (6.4%), n = 14 (3.2%), n = 8 (1.8%), and n = 7 (1.6 %) for impacted tooth, displaced tooth, ectopic tooth, inversion and infraposition, respectively.

Pathology caused by dental anomaly was detected in 26 patients (6%), and the most common pathology was cystic lesion (n = 13, 3%), followed by impaction (n = 10, 2.3%) and apical lesion (n = 3, 0.7%). There was no significant relationship between pathology caused by dental anomaly and the type of dental anomaly ($P = 0.168$).

Table 1. Intra-observer and inter-observer agreement coefficients

	O1-O1	O2-O2	O1-O2
Presence of dental anomaly	0.97	0.98	0.95
Type of dental anomaly	0.96	0.96	0.94
Dental anomaly subtype	0.96	0.94	0.94
Presence of pathology	0.85	0.86	0.85
Type of pathology	0.85	0.86	0.85

Kappa coefficient; O: observer.

Discussion

Dental anomaly refers to teeth of unusual shape, number, structure, position, and size.[11] Genetic, traumatic, systemic, or geographical factors may be effective in its etiology.[12] To determine the prevalence in the geographical region examined in the present study, images of patients with genetic or systemic disease and trauma history, and images of patients who did not live in the studied region were removed from the study.

Dental anomalies were identified in 1.73% to 74% of the studied population.[4,13-15] Our study identified a 21.3% prevalence of dental anomalies within the investigated population. Considering other studies on subjects of the same race, the prevalence of dental anomalies ranges from 2% to 39.2%.[9,11,16,17] The large difference in prevalence may be due to sample size differences, inclusion criteria, or diagnostic criteria.[16] The current study may be more reliable because the sample size was determined before the study started. The prevalence of dental anomalies may be affected by the study group, especially in studies conducted with certain groups of patients. For example, a dental anomaly is a condition requiring orthodontic treatment. Therefore, it can be expected that the probability of dental anomalies is higher in populations that consist only of orthodontic patients. The present study excluded images of individuals with any disease affecting the craniofacial region. It was conducted on images of patients who referred for routine dental examinations in systemically healthy conditions. Therefore, our study gives results reflecting the general population. In addition, this study enrolled both pediatric and adult patients, categorized into two distinct groups for further analysis: < 18 years and ≥ 18 years. Previous studies conducted in the same racial region have documented a 2% prevalence of developmental dental anomalies.[17] This study revealed a significantly higher prevalence of dental anomalies in individuals under 18

Table 2. Distribution of type of dental anomaly according to gender and age

	Shape anomaly (n/%)	Number anomaly (n/%)	Structure anomaly (n/%)	Position anomaly (n/%)	Size anomaly (n/%)	Total (n/%)
Female	17/8.13	48/22.97	3/1.44	139/66.51	2/0.95	209/100
Male	24/10.62	67/29.65	0/0	132/58.4	3/1.33	226/100
< 18 years old	19/9.31	57/27.95	1/0.49	126/61.76	1/0.49	204/100
≥ 18 years old	22/9.52	58/25.11	2/0.87	145/62.77	4/1.73	231/100

%: percentage; *n*: number of patients.

Table 3. Distribution of dental anomalies according to the subtype of dental anomaly

Dental anomaly type and subtype	Number	%
Shape anomaly	41	9.4
Taurodontism	7	1.6
Dilation	11	2.5
Accessory stem	1	0.2
Fusion/gemination	1	0.2
Dens invaginatus	21	4.8
Number anomaly	115	26.4
Hyperdontia	89	20.4
Hypodontia	26	6
Structure anomaly	3	0.7
Odontodysplasia	1	0.2
Pre-eruptive intracoronal resorption	2	0.5
Position anomaly	271	62.3
Impacted tooth	214	49.2
Ectopic tooth	14	3.2
Inversion	8	1.8
Displaced tooth	28	6.4
Infraposition	7	1.6
Size anomaly	5	1.1
Microdontia	5	1.1

years old (67%) compared to those aged 18 years and older (14.1%), with a statistically significant difference ($P<0.001$). This result suggests that dental anomalies are mostly detected in the pediatric period, and the reason for the decrease in prevalence with age may be the treatment of dental anomalies at an early age.

Our analysis revealed no significant association between the presence of dental anomalies and patient gender ($P=0.312$). This result was consistent with the findings of Esenlik et al[18] Kapdan et al[17] found this prevalence to be higher in males than females, but Büyükgöze-Dindar and Tekbaş Atay[11] and Bilge et al[9] found this prevalence to be higher in females than males.

The literature shows that digital panoramic radiographic images are routinely used for detecting dental anomalies[19] The limitations of two-dimensional images, such as superposition, distortion, and detection resorptions less than 0.3 mm deep, should be considered.[20] CBCT allows us to obtain three-dimensional information about the type of dental anomaly, its position, and local pathologies in adjacent teeth.[21] The use of CBCT in the present study makes it superior to other studies, especially in detecting pathologies. However, CBCT is not a routine imaging method. Since the radiation dose is relatively high compared to conventional radiographs, its benefit in diagnosing and treating the anomaly should be considered. The current study was conducted retrospectively, so patients were not exposed to extra radiation doses.

The most common type of anomaly in the current study was position anomalies, and the most common subtype of this type of anomaly was impacted teeth (Table 3). These results were similar to those of Bilge et al,[9] who recorded third molars as impacted teeth; however, these cases were not evaluated as impacted in our study. Also, considering the age of the individuals in the mixed dentition period in the present study, it was assumed that some teeth had not erupted physiologically because their eruption time had not arrived yet; these teeth were not evaluated as dental anomalies either.

A study in the literature reported that number anomalies were the most common dental anomalies.[22] In the present study, number anomalies were the second most common anomaly, and the most common subtype of number anomaly was hypodontia (Table 3). Hyperdontia is a type of dental anomaly that can occur in any part of the jaws and result in additional teeth erupting within the dental arch.[18] Büyükgöze-Dindar and Tekbaş Atay[11] and Atay et al[23] found hypodontia to be the most common number anomaly (1.5%). In our study, the prevalence of hypodontia was 6%, consistent with the range specified in the literature (0.15%–16.2%).[24,25] Temilola et al[26] found that the prevalence of number anomalies was very low while dens invaginatus was highly common. In the current study, shape anomalies were detected in 41 individuals, and the most common subtype of shape anomaly was dens invaginatus. It is a malformation of the tooth crown caused by the inward invagination of the enamel-forming tissue (enamel organ) into the tooth germ (dental papilla) during the early stages of tooth development.[27] The incidence of dens invaginatus in the Turkish population varies between 1.3% and 12%.[24,28] In a study based on CBCT on the Chinese population, dens invaginatus was seen in 85 (8.47%) out of 1004 patients,[29] which is higher than the present study results.

One of the other important shape anomalies is taurodontism. In taurodontism, the furcation area is positioned apically, resulting in amplification of the pulp chamber and diminutive roots and root canals.[30] The occurrence of taurodontism exhibits substantial variation across diverse populations. The prevalence of taurodontism is lower in the German population (2%), but higher in Turkish (11%) and Iranian population (23%).[9,31,32] This study observed a taurodontism prevalence of 1.6%. In addition, as far as we know, there is no study examining the prevalence of taurodontism with CBCT.

The least common subtypes of dental anomalies in the current study were odontodysplasia, fusion/gemination, and accessory root (equal number for each, n = 1, 0.2%). Odontodysplasia is a rare developmental anomaly affecting dental tissue's mesoderm and ectoderm.[33] Guimarães Cabral et al found only one case of odontodysplasia, as in the current study.[34] While fusion occurs by the union of two different dental tissues, gemination occurs by the splitting of a dental tissue in two.[35] Studies showing fusion/gemination prevalence are very few, and the number of fusion/gemination cases is between three and 53 in different studies.[35] Şekerci et al, in Turkey, found the incidence of twin teeth to be 0.38%.[36] The accessory root is a tissue growth originating from the Hertwig epithelial root sheath[37] commonly occurring in mandibular canines, premolars, and molars (often third molars).[38] Guttal et al reported accessory roots in mandibular premolars and first molars to be more common in males and constitute 2% of total anomalies.[39]

In a study conducted with orthodontic patients in the Brazilian population, they identified ectopia (35.1%) as the most prevalent developmental anomaly, followed by microdontia (30.1%) and impaction (21.4%).[40] The present study detected few cases of ectopia and microdontia (3.3% and 1.1%, respectively). These differences in the studies can be due to differences in age, size, diagnostic methods, and environmental and genetic factors of the studied population.[4]

In the current study, pathology due to the dental anomaly was also investigated and detected in 26 patients (6%). The most common pathology was cystic lesion (n = 13, 3%), followed by impaction (n = 10, 2.3%) and apical lesion (n = 3, 0.7%). There was no significant relationship between pathology due to the dental anomaly and the type of dental anomaly ($P = 0.168$).

While recognizing the potential biases introduced by the retrospective design and unknown clinical history, this research presents a pioneering use of CBCT in uncovering potential pathological consequences of dental anomalies. A thorough literature review revealed no comparable investigation utilizing this technology, making the present study a useful contribution to the literature.

Limitation

The present study's limitations include the small number of individuals included in the study and the study's retrospective design. As a result, all risk factors could not be assessed.

Conclusion

Dental anomaly occurrences might exhibit geographical disparities. The prevalence of dental anomaly was 21.3% in the present study, and the most frequent type was position anomaly. Such studies specific to societies will contribute to the dentists' knowledge of the prevalence of the most common anomaly types in that region and the suitable treatment plan.

Acknowledgments

The authors thank Akdeniz University for providing unlimited access to patient records.

Authors' Contribution

Conceptualization: Rümeysa Şendişçi Gök, Hümeyra Tercanlı Alkış.
Data curation: Rümeysa Şendişçi Gök, Hümeyra Tercanlı Alkış.
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Competing Interests

None.

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