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Determining the Incidental Pathologic Findings (IPFs) on Panoramic Radiographs before Orthodontic Treatments: a Retrospective Study

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SUMMARY

Background/Aim: *Panoramic radiography is an imaging method that displays teeth, jaws and surrounding structures in two dimensions and is frequently used in the follow-up and treatment phase of patients. This study aims to determine the frequency of incidental findings (IPFs) in panoramic radiographs taken before orthodontic treatment.* ***Material and Methods:*** *In this retrospective study; A total of 330 patients (170 women, 160 men) aged between 7 and 49 years were included. IPFs were grouped into dental anomalies, radiopacities and radiolucent areas in the jaws, impacted teeth, and other anomalies in the jaws. Data were compared according to gender and age groups (6-12 years, 13-49 years).* ***Results:*** *Dental anomalies were detected in 90.6% of the panoramic radiographs examined. No statistically significant relationships were found between gender and dental abnormalities ($p>0.05$). The incidence of idiopathic osteosclerosis is 3.6%, and all of these people are men; It has been determined that people with sclerosing osteitis are mostly men and alveolar radiopacities are mostly not seen in women. It has been observed that patients are mostly between the ages of 6-12 in the absence of any dental anomalies. It has been determined that people with sclerosing osteitis are mostly between the ages of 13-49 and patients aged 13-49 mostly have alveolar radiopacities. It has been determined that patients with possible periapical or residual cyst and possible dentigerous cyst are mostly between the ages of 13-49, and patients aged 13-49 are mostly seen in radiolucent areas in the jaw bones. As a result of the analysis, a statistically significant relationship was found between age groups and IPFs ($p<0.05$).* ***Conclusions:*** *According to the results of this study, a high rate of dental anomalies were detected by evaluating panoramic radiographs before orthodontic treatment. Age and gender changes play a role in the presence of Incidental Pathologic Findings.*

Key Words: Incidental Pathologic Findings, Orthodontic Treatment, Panoramic Radiography

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Introduction

Intraoral and extraoral radiographs are routinely used in the diagnosis, treatment planning and follow-up of orthodontic malocclusions. The most commonly used radiography methods in orthodontics are lateral cephalometric and panoramic radiographs [1]. Pathological conditions can be detected in lateral cephalometric x-rays, which are frequently used by orthodontists to evaluate dental and skeletal structures for treatment planning [2]. However, these incidental findings can often be overlooked. If pathological conditions cannot be diagnosed in the early stages, more invasive treatment methods are used in the future [1, 3-5].

Panoramic radiography is an extraoral radiography method frequently used in general dentistry. Teeth, jaws and structures surrounding the teeth are evaluated with panoramic radiographs. Panoramic radiography can be used to evaluate dental anomalies such as cysts, tumors, TMJ disorders, sinus pathologies and fractures, condylar structure, jaw fractures, impacted teeth, congenital missing teeth, supernumerary teeth, and hard and soft tissue pathological conditions [3, 6-10].

Bondemark et al. detected abnormalities and pathological findings in 8.7% of patients who received panoramic x-rays before orthodontic treatment. According to this study, the most common findings are radiopacity in the alveolar bone, mucosal thickening in the maxillary sinuses, and periapical lesions; Periapical lesions, cysts within the alveolar bone, dentigerous cysts, marginal bone loss and odontoma were detected in 32.1% of the findings[4].

The aim of this retrospective study was to evaluate the frequency of incidental findings in panoramic radiographs taken from patients applying to the orthodontic clinic and the relationship of these findings with age and gender.

Material and methods

A retrospective cross-sectional study was conducted using radiographs from 1 January 2020 to 31 December 2022. All panoramic radiographs were selected from the archives of private dental practices in Istanbul. In this research, "G. Using the "Power-3.1.9.2" program, the sample size that would yield the highest number in line with the main hypotheses at a 95% confidence level was determined [10, 11]. As a result of the analysis, α=0.05, the standardized effect size was obtained as 0.3198 from the previous study, and the minimum sample size was calculated as 194 with a theoretical power of 0.95 [12]. The study consists of panoramic radiographs taken from the patient before treatment within the scope of the orthodontic treatment plan. 330 randomly selected patients, 170 women and 160 men, aged between 7 and 49, were included in the study. A maximum of 30 radiographs were evaluated simultaneously to minimize the risk of questionable evaluation caused by fatigue. Information such as the patients' name, age, gender, and indication for panoramic radiography were recorded. All uninformative and inaccurate images were excluded from the study.

Inclusion criteria

Dental records of patients older than 6 years and panoramic radiographs with good quality contrast and minimal distortion were included in the study.

Exclusion Criteria

Patients younger than 6 years of age, patients with incomplete records, radiographs showing low-resolution images and significant artifacts, images of patients with previous jaw surgery, prosthetic treatment, large dental restorations that prevented the observation of crown morphology, and patients of unknown age or gender were excluded from the study.

All primary and permanent teeth, including the third molars, were examined using panoramic radiographs previously taken by the patients. Images were exported and saved without adjustments to contrast, brightness, or magnification. Gender and age were recorded for each patient. Selected IPFs detected on these radiographs were divided into the following categories: dental anomalies (congenital missing teeth, supernumerary teeth, impacted teeth, transposed teeth, root fragments, macrodontia, microdontia, dilaceration); radiopacities in the jaw (idiopathic osteosclerosis, sclerosing osteitis); radiolucent areas in the jaw bones (possible or residual cyst, possible dentigerous cyst); and other anomalies (metal fixation, thickening of the sinus mucosa).

Statistical Method

Descriptive statistics (number, percentage, mean, standard deviation, minimum and maximum) of the data are given in the study. As the first step in analyzing the data, the assumption of normality was checked with the Shapiro Wilk test. Mann Whitney U test was used to compare the means of two independent groups that were not normally distributed. When sample size adequacy is achieved in the analysis of categorical data (expected value > 5), Pearson Chi Square analysis; When it was not provided, Fisher's Exact test was applied. Multiple Chi Square test was applied to examine the relationships between multiple choice categorical variables. Analyzes were carried out in IBM SPSS 25 program.

Results

A total of 330 panoramic radiographs were analyzed and tooth-related anomalies were found in 90.6% of the radiographs. Table 1 showed the demographic characteristics of the sample consisting of 160 men and 170 women. Of the total 330 panoramic radiographs, 52.4% were from female patients and 47.6% were from male patients. In Table 1, the rate of patients between the ages of 6-12 was 23.9%, and the rate of patients between the ages of 13-49 was 76.1%.

In Table 2, 31.1% of tooth-related anomalies were impacted teeth, 26% were supernumerary teeth, 2% were mesiodense, and 13.7% were congenitally missing teeth.

Table 1. Distribution of patients according to demographic characteristics

		n	%
Age	6-12 years	79	23.9
	13-49 years	251	76.1
Gender	Female	170	52.4
	Male	157	47.6

	n	Min.	Max.	Mean	Standart Deviation	Median
Age	330	7	49	15.59	5.31	15

It was observed that 10% of the dental anomalies were macrodentia, 2% were transposed teeth and 1% were ectopic teeth. As seen in Table 2, the most commonly impacted tooth was the maxillary right canine with a rate of 30.9%. The most common congenitally missing teeth were maxillary lateral teeth with a rate of 6.4%, followed by mandibular left second premolar teeth with a rate of 3%. In the panoramic x-rays examined, the rate of crowding in the maxilla was 79.1% and the rate of gaps was 10.9%; The rate of crowding in the mandible was found to be 74.2%, and the rate of gap was found to be 14.5%. It was determined that the rate of rotation of teeth was 81.8%, the rate of rotation of one tooth was 31.5%, and the rate of rotation of two teeth was 40.7%. According to Table 2, it was observed that 3.6% had pulp stones. The incidence of IPFs was mostly seen in the posterior mandible with 80.3% and in the posterior maxilla with 66.4%.

Table 2. Distribution of patients according to clinical characteristics

		n	%
Dental related anomalies		299	90.6
	Impacted tooth	93	31.1
	Superimposition of third molars on mandibular canal	203	67.9
	Supernumerary tooth	78	26.1
	Mesiodens	6	2.0
	Congenitally missing permanent tooth	41	13.7
	Missing tooth (extracted or lost)	49	16.4
	Dilacerated root	211	70.6
	Root tips embedded in alveolar bone	7	2.3
	Root resorption	9	3.0
	Taurodontism	1	0.3
	Microdontia	42	14.0
	Ectopic teeth	3	1.0
	Transpose teeth	6	2.0
	Macrodontia	30	10.0
Impacted teeth		97	29.4
	Maxillar impacted third molar right	5	5.2
	Maxillar impacted third molar left	6	6.2
	Maxillar impacted canine right	30	30.9
	Maxillar impacted canine left	22	22.7
	Mandibular impacted third molar right	27	27.8
	Mandibular impacted third molar left	21	21.6
Alveolar radiopacities	Idiopathic osteosclerosis	12	3.6
	Sclerosing osteitis	18	5.5
Radiolucent areas in the jaw bones	Possible periapical or residual cyst	61	18.5
	Possible dentigerous cyst	31	9.4
Other anomalies	Metal fixation	3	0.9
	Thickening of the sinus mucosa	19	5.8
Incidental Pathologic Findings (IPFs)	Anterior maxilla	143	43.3
	Posterior Maksilla	219	66.4
	Anterior mandibula	77	23.3
	Posterior mandibula	265	80.3
Periodontal space widening		61	18.5
Pulp stones		12	3.6
Rotated teeth		270	81.8
Filled teeth		202	61.2
Decayed teeth		244	73.9
Possible unerupted teeth		233	70.6
Maxillar crowding		261	79.1
Mandibular crowding		245	74.2

	n	Minimum	Maximum	Mean	Standard Deviation	Median
Rotated teeth	330	0	10	1.77	1.45	2
Filled teeth	330	0	14	2.39	2.76	2
Decayed teeth	330	0	10	2.22	2.00	2
Possible unerupted teeth	330	0	6	2.39	1.89	3

***Multiple Chi Square test, %: Percentage of rows %G: Percentage of gender

No statistically significant relationships were obtained between the gender of the patients and the presence of dental abnormalities and the existing abnormalities ($p>0.05$).

No statistically significant relationships were found between the gender of the patients and the impacted tooth status and impacted tooth number ($p>0.05$) (Table 3).

A statistically significant relationship was found between the gender of the patients and the alveolar radiopacities status ($p<0.05$). When the observations were examined for the reason for the relationship, all of the people with Idiopathic osteosclerosis were male; It was found that people with sclerosing osteitis were mostly men, and alveolar radiopacities were mostly not seen in women (Table 3).

A statistically significant relationship was determined between gender and other anomalies ($p<0.05$). When the observations were examined for the reason for the relationship, it was found that people with metal fixation were mostly men and other anomalies were mostly not observed in women (Table 3).

No statistically significant relationship was found between gender and Radiolucent areas in the jaw bones ($p>0.05$) (Table 3).

Table 3. Relationship and cross-tabulation between patients' gender and impacted tooth status

	Female			Male				
	n	%	% G	n	%	%G	Test statistics	p
Impacted teeth								
Absence	118	50.6	68.2	115	49.4	73.2	1.008	0.316
Presence	55	56.7	31.8	42	43.3	26.8		
Maxillar impacted third molar right	3	60.0	5.5	2	40.0	4.8	4.674***	0.912
Maxillar impacted third molar left	4	66.7	7.3	2	33.3	4.8		
Maxillar impacted canine right	18	60.0	32.7	12	40.0	28.6		
Maxillar impacted canine left	15	68.2	27.3	7	31.8	16.7		
Mandibular impacted third molar right	16	59.3	29.1	11	40.7	26.2		
Mandibular impacted third molar left	11	52.4	20.0	10	47.6	23.8		
Mandibular impacted canine right	1	50.0	1.8	1	50.0	2.4		
Mandibular impacted canine left	1	100.0	1.8	0	0.0	0.0		

***Multiple Chi Square test, %: Percentage of rows %G: Percentage of gender

Table 4. Relationship and cross-tabulation between gender of patients and clinical findings

	Female			Male				
	n	%	%G.	n	%	%G.	Test statistics	p
Alveolar radiopacities								
Absence	169	56.3	97.7	131	43.7	83.4	21.644	0.000*
Idiopathic osteosclerosis	0	0.0	0.0	12	100.0	7.6		
Sclerosing osteitis	4	22.2	2.3	14	77.8	8.9		
Radiolucent areas in the jaw bones								
Absence	122	51.3	70.5	116	48.7	73.9	3.281	0.183
Possible periapical or residual cyst	30	49.2	17.3	31	50.8	19.7		
Possible dentigerous cyst	21	67.7	12.1	10	32.3	6.4		
Other anomalies								
Absence	170	55.2	98.3	138	44.8	87.9	15.623**	0.000*
Metal fixation	1	33.3	0.6	2	66.7	1.3		
Thickening of the sinus mucosa	2	10.5	1.2	17	89.5	10.8		

*p<0.05, **Fisher's Exact test, %: Percentage of rows, %G: Percentage of gender

Statistically significant relationships were found between the age groups of the patients and the dental abnormalities and existing abnormalities ($p<0.05$). It was observed that patients without dental anomalies were mostly between the ages of 6-12, and in cases with anomalies, the patients were mostly between the ages of 13-49. It was determined that the patients with third molars superimposed on the mandibular canal, supernumerary teeth, missing teeth and dilated roots were mostly between the ages of 13-49 (Table 5).

Table 5. Relationship and cross-tabulation between patients' ages and presence of dental abnormalities

	6-12 years			13-49 years				
	n	%	%A.	n	%	%A.	Test statistics	p
Dental anomalies								
Absence	21	67.7	26.6	10	32.3	4.0	36.052	0.001*
Presence	58	19.4	73.4	241	80.6	96.0		
Impacted tooth	22	23.7	37.9	71	76.3	29.5	55.086***	0.000*
Superimposition of third molars on mandibular canal	26	12.8	44.8	177	87.2	73.4		
Supernumerary tooth	16	20.5	27.6	62	79.5	25.7		
Mesiodens	2	33.3	3.4	4	66.7	1.7		
Congenitally missing permanent tooth	11	26.8	19.0	30	73.2	12.4		
Dilacerated root	34	16.1	58.6	177	83.9	73.4		
Root tips embedded in alveolar bone	0	0.0	0.0	7	100.0	2.9		
Root resorption	3	33.3	5.2	6	66.7	2.5		
Taurodontism	1	100.0	1.7	0	0.0	0.0		
Microdontia	8	19.0	13.8	34	81.0	14.1		
Ectopic teeth	3	100.0	5.2	0	0.0	0.0		
Transpose teeth	2	33.3	3.4	4	66.7	1.7		
Makrodontia	6	20.0	10.3	24	80.0	10.0		

***Multiple Chi Square test, %: Row percentage, %A.: Age percentage

Table 6. Relationship and cross-tabulation between patients' ages and clinical findings

	6-12 years			13-49 years				
	n	%	%A.	n	%	%A.	Test statistics	p
Alveolar radiopacities								
Absence	70	23.3	88.6	230	76.7	91.6	8.215**	0.013*
Idiopathic osteosclerosis	7	58.3	8.9	5	41.7	2.0		
Sclerosing osteitis	2	11.1	2.5	16	88.9	6.4		
Radiolucent areas in the jaw bones								
Absence	68	28.6	86.1	170	71.4	67.7	10.506	0.005*
Possible periapical or residual cyst	6	9.8	7.6	55	90.2	21.9		
Possible dentigerous cyst	5	16.1	6.3	26	83.9	10.4		
Others anomalies								
Absence	76	24.7	96.2	232	75.3	92.4	1.023**	0.641
Metal fixation	0	0.0	0.0	3	100.0	1.2		
Thickening of the sinus mucosa	3	15.8	3.8	16	84.2	6.4		

*p<0.05, **Fisher's Exact test, %: Row percentage and %A.: Age percentage

No statistically significant relationships were found between the patients' age groups, impacted tooth status, and impacted tooth number (p>0.05) (Table 5).

Statistically significant relationships were found between the age groups of the patients and the conditions of Alveolar radiopacities and Radiolucent areas in the jaw bones (p<0.05). It was determined that people with sclerosing osteitis were mostly between the ages of 13-49, and patients between the ages of 13-49 mostly had alveolar radiopacities. It was determined that patients with possible periapical or residual cysts and possible dentigerous cysts were mostly between the ages of 13-49, and patients between the ages of 13-49 were mostly seen in radiolucent areas in the jaw bones. (p>0.05).

Statistically significant relationships were found between the patients' age groups and caries status (p<0.05). It was found that the incidence of caries was higher in patients between the ages of 13-49 (Table 6).

Statistically significant relationships were found between age groups and tooth numbers with a high risk of non-eruption (p<0.05).

No statistically significant relationships were found between ages and the status of a rotated, filled tooth, a tooth with a high risk of failure to erupt, a persistent primary tooth and a permanent underlying tooth, or a persistent primary tooth and a permanent underlying tooth (p>0.05).

A statistically significant difference was found between the average number of decayed teeth of the patients according to their age groups ($p < 0.05$). The average number of decayed teeth in the 13-49 age group was higher than the average number of decayed teeth in the 6-12 age group.

No statistically significant relationship was found between the age groups of the patients and their crowding and spacing conditions ($p > 0.05$).

No statistically significant relationship was found between the age groups of the patients and the number of missing congenital teeth ($p > 0.05$). A statistically significant relationship was found between the age groups of the patients and Incidental Pathologic Findings ($p < 0.05$).

Discussion

In our study, the IPFs rate was found to be 91%. In studies conducted, the incidence of IPFs in panoramic and lateral cephalometric radiographs varies between 6.2% and 70% [13-17]. This high range of variability may be related to differences in sample size, geographic factors, ethnic differences, and observer experience. Bondemark et al. reported the incidence of IPFs as 8.7%[4]. In their study, Vaseemuddin et al evaluated the panoramic x-rays of 410 patients and reported the IPFs rate as 50%[5]. Among other researchers, Roopashri reported the IPFs rate as 64%, Hlongwa et al. reported the IPFs prevalence as 38%, and Ezoddini et al. reported the IPFs prevalence as 40.8%[12, 18, 19]. Hernandez et al found the prevalence of IPFs findings to be 88.12%, which is compatible with the results of our study[1].

According to the study conducted by Hlongwa et al., the prevalence of idiopathic osteosclerosis was found to be 13%[12]. Cederhag et al. reported the prevalence of idiopathic osteosclerosis as 20%[20]. In the study by Bondemark et al., they found a lower prevalence of idiopathic osteosclerosis at 4.4%[4]. Other studies have reported prevalence ranging from 2.7% to 10.7% [10, 12, 21].

In the study conducted by Hlongwa et al., the incidence of thickening of the sinus mucosa was reported as 3% [12]. Bondemark et al. reported a 3% prevalence for mucosal thickening of the sinuses, while Vaseemuddin et al reported mucosal thickening in 3% of cases in their study [4, 5]. In our study, the frequency of thickening of the sinus mucosa was found to be 5.8%. The findings in our study are compatible with the results of these studies. Other studies on thickening of the sinus mucosa have reported higher prevalence, ranging from 7% to 21.22% [12, 20, 22, 23]. These differences can be explained by the study population, geographical conditions, and ethnic differences.

Hlongwa et al. reported that the incidence of IPFs was higher in the mandible (50.8%) than in the maxilla (49.2%) [12]. The results of our study are also compatible with this study. In our study, the incidence of IPFs was found to be higher in the posterior mandible, with an incidence of 80.3%, compared to the posterior maxilla (66.4%).

According to the study conducted by MacDonald et al. in 2020, they found the idiopathic sclerosis rate to be 6.0%. In their systematic review, Mac Donald et al reported that the prevalence of idiopathic sclerosis ranged from 2.7% to 6.7%, with a higher prevalence in Hong Kong Chinese [10, 21]. In our study, the incidence of idiopadic sclerosis was found to be 3.6%, consistent with these studies.

Hlongwa et al. found the prevalence of impacted teeth to be 49% [12]. Compared to MacDonald and Yu's study, this study found that impacted teeth were more common in women. The prevalence of impacted teeth has been reported to range from 4.4% to 29.6% [10]. In our study, the incidence of impacted teeth was found to be 29.4%. In our study, the most common impaction rate was the maxillary right canine with 30.9%, the mandibular right third molar with 27.8%, and the maxillary left canine with 22.7%, respectively.

Filho et al. evaluated the prevalence of dental anomalies on panoramic radiographs and found that the prevalence of taurodontism was 27.19% [8]. In the study of Hernandez et al., the prevalence of taurodontism was reported as 1.74%, Saberi and Ebrahimipour reported this rate as 5.38%, and Kuhlberg and Norton reported the prevalence of taurodontism as 0.25% [1, 24, 25]. In our study, the prevalence of taurodontism was found to be 0.3%, which is consistent with the study of Kuhlberg and Norton.

It is one of the most common dental anomalies worldwide, with the prevalence of congenital missing teeth varying between 1.6% and 45.7%. Aikins et al. found this prevalence rate to be 4.4% [6]. In our study, the prevalence of congenital missing teeth was found to be 13.7%. According to the results of our study, the most common congenitally missing teeth are the right and left maxillary lateral teeth with a rate of 6.4%, respectively, followed by the mandibular left second premolar tooth with a rate of 3%, and the third one is the mandibular right second premolar tooth with a rate of 2.1%. Aikins et al. reported in their study that the most common congenital tooth deficiency is the upper lateral incisors, and it is compatible with our study. In their study in Saudi Arabia, Alhumaid et al. reported that mandibular second premolar teeth are the most common congenital teeth [6, 7]. This difference may be explained by racial differences and the different size of the sample size.

In our study, the prevalence of possible dentigerous cysts was found to be 9.4%. In the study by Hlongwa et al., the prevalence of dentigerous cysts was 1%, while

Hernandez et al. reported a prevalence of 5.34% for dentigerous cyst [1, 12]. The prevalence rate in these studies is lower than the findings of our study.

In our study, we found the prevalence of periapical and residual cysts to be 18.5%. In the study of Hlongwa et al., the incidence of cysts in the alveolar bone was reported as 2% [12]. Bondemark et al. reported a much lower prevalence of 0.4% for cysts in the alveolar bone [4]. Granlund et al. reported that the prevalence of cysts in the alveolar bone was 1.01% [9]. These rates are quite low compared to the findings in our study. The reason for the higher prevalence rate in our study may be due to sample size, racial differences and observer experience.

In our study, the frequency of supernumerary teeth constitutes 26.1% of all findings. There are studies in the literature showing that supernumerary teeth are more common in men than in women[6, 26]. Aikins et al. found that the prevalence of supernumerary teeth was higher in women[6]. In our study, the frequency of supernumerary teeth was found to be equal in female (50%) and male (50%) patients. In the study of Alhumaid et al., the prevalence of supernumerary teeth was stated as 1.8%, and in the study of Pallikaraki et al., the prevalence of supernumerary teeth was stated as 1% [7, 27]. In Bäckman and Wahlin's study, they found that the prevalence of supernumerary teeth was 1.9% in the Caucasian population [28]. The higher prevalence in our study may be due to differences in ethnicity and evaluation methods.

In our study, the incidence of transposed teeth constitutes 1.8% of all cases. In the study conducted by Papadopoulos, the frequency of transposed teeth was reported as 0.33%, Hatzoudi and Papadopoulos as 0.09%, Yılmaz et al. as 0.38%, and Chattopadhyay et al. as 0.40% [28-32]. Our study is consistent with the 1.4% prevalence of transposed teeth reported by Onyeaso et al [26].

In our study, the prevalence of periodontal space widening constitutes 18.5% of the cases showing signs of dental anomalies, and the prevalence of pulp stones constitutes 3.6% of the cases showing signs of dental anomalies. In the study of Hlongwa et al., these rates were reported as 11.9% and 5.9%, respectively [12]. These findings are consistent with the findings of our study.

Conclusions

Panoramic radiographs are a preferred routine diagnostic tool in the evaluation of anomalies, lesions, cysts, etc. related to dental conditions. According to the results of this study, a high rate of dental anomalies were detected by evaluating panoramic radiographs before orthodontic treatment. Age and gender changes may play a role in the presence of Incidental Pathologic Findings. The presence of IPFs may be effective for dentists' diagnosis and treatment planning, especially in orthodontics. Further studies should be conducted using a study sample including all panoramic radiographs and clinical findings from the dental schools and dental clinics, covering more patients with further supervision and quality assurance.

References

1. Hernández G, Plaza SP, Cifuentes D, Villalobos LM, Ruiz LM (2018). "Incidental findings in pre-orthodontic treatment radiographs". *Int Dent J*. **68** (5): 320-326. doi: 10.1111/idj.12389. PMID: 29607488
2. Klenke D, Santander P, Vehring C, Quast A, Sommerlath Sohns J, Krohn S, et al. (2023). "Prevalence of incidental findings in adult vs. adolescent patients in the course of orthodontic X-ray diagnostics". *J Orofac Orthop*. **84** (5): 298-310. doi: 10.1007/s00056-022-00399-2. PMID: 35585297
3. Bawazir M, Alyousef T, El-Housseiny AA (2019). "Incidental Dental Anomalies in Pediatric Dental Patients Detected by Panoramic Radiographs–A Retrospective Study". *Saudi J Oral Dent Res*. **4** (2): 87-92. doi:10.21276/sjodr.2019.4.2.8
4. Bondemark L, Jeppsson M, Lindh-Ingildsen L, Rangne K (2006). "Incidental findings of pathology and abnormality in pretreatment orthodontic panoramic radiographs". *Angle Orthod*. **76** (1): 98-102. doi: 10.1043/0003-3219(2006)076[0098:IFOPAA]2.0.CO;2. PMID: 16448276
5. Vaseemuddin S (2016). "Incidental findings on panoramic radiograph: A clinical study". *J Adv Med Dent Scie Res*. **4** (6): 43-55. doi: 10.21276/jamdsr.2016.4.6.54
6. Aikins AE, Ututu C, Chukwuma E (2022). "Prevalence of Incidental Dental Anomalies seen on Pre-Treatment Digital Panoramic Radiographs of a Group of Nigerian Orthodontic Patients: A Retrospective Study". *Niger Dent J*. **7** (1): 67-74. doi.org/10.4314/njdr.v7i1.9
7. Alhumaid J, Buholayka M, Thapasum A, Alhareky M, Abdelsalam M, Bughsan A. (2021). "Investigating prevalence of dental anomalies in Eastern Province of Saudi Arabia through digital orthopantomogram". *Saudi J Biol Sci*. **28** (5): 2900-2906. doi: 10.1016/j.sjbs.2021.02.023. PMID: 34025167
8. Goncalves-Filho AJ, Moda LB, Oliveira RP, Ribeiro ALR, Pinheiro JJ, Alver-Junior SM (2014). "Prevalence of dental anomalies on panoramic radiographs in a population of the state of Pará, Brazil". *Indian J Dent Res*. **25** (5): 648-652. doi: 10.4103/0970-9290.147115. PMID: 25511067.
9. Granlund CM, Lith A, Molander B, Gröndahl K, Hansen K, Ekestubbe A (2012). "Frequency of errors and pathology in panoramic images of young orthodontic patients". *Eur J Orthod*. **34** (4): 452-457. doi: 10.1093/ejo/cjr035. PMID: 21511820
10. MacDonald D, Yu W (2020). "Incidental findings in a consecutive series of digital panoramic radiographs". *Imaging Sci Dent*. **50** (1): 53. doi: 10.5624/isd.2020.50.1.53. PMID: 32206621
11. Cohen J (2013). "Statistical power analysis for the behavioral sciences". *Academic press*.

12. Hlongwa P, Moshaoa MAL, Musemwa C, Khammissa RAG (2023). "Incidental Pathologic Findings from orthodontic pretreatment panoramic radiographs". *International Journal of Environmental Research and Public Health*. **20** (4): 3479. doi: 10.3390/ijerph20043479.
13. Choi JY, Oh SH, Kim SH, Ahn HW, Kang YG, Choi YS, et al. (2021). "Effectiveness of 2D radiographs in detecting CBCT-based incidental findings in orthodontic patients". *Sci Rep*. **11** (1): 9280. doi: 10.1038/s41598-021-88795-3. PMID: 33927309
14. Jose M, Varghese J (2011). "Panoramic radiograph a valuable diagnostic tool in dental practice-Report of three cases". *Int J Dent Clin*. **3** (4): 47-49.
15. Langlais RP, Langland OE, Nortjé CJ. Diagnostic imaging of the jaws: Lippincott Williams & Wilkins; 1995. 678 p.
16. Okşayan R, Aktan AM, Sökücü O, Haştar E, Ciftci ME (2012). "Does the panoramic radiography have the power to identify the gonial angle in orthodontics?". *Sci World J*. 2012. doi: 10.1100/2012/219708. PMID: 23365514
17. Sotirios T, Kantor LM. (1999). "Prevalence of skeletal and dental anomalies and normal variants seen in cephalometric and other radiographs of orthodontic patients". *Am J Orthod Dentofacial Orthop*. **116** (5): 572-577. doi.org/10.1016/S0889-5406(99)70191-5
18. Ezoddini AF, Sheikhha MH, Ahmadi H (2007). "Prevalence of dental developmental anomalies: a radiographic study". *Community Dent Health*. **24** (3): 140-144. PMID: 17958073
19. Roopashri G, Vaishali M, David MP, Baig M, Shankar U (2012). "Evaluation of elongated styloid process on digital panoramic radiographs". *J Contemp Dent Pract*. **13** (5): 618-22. doi: 10.5005/jp-journals-10024-1197. PMID: 23250163
20. Cederhag J, Lundegren N, Alstergren P, Shi X-Q, Hellén-Halme K (2020). "Evaluation of panoramic radiographs in relation to the mandibular third molar and to incidental findings in an adult population". *Eur J Dent*. **15** (02): 266-272. doi: 10.1055/s-0040-1721294. PMID: 33368065
21. MacDonald-Jankowski D (1999). "Idiopathic osteosclerosis in the jaws of Britons and of the Hong Kong Chinese: radiology and systematic review". *Dentomaxillofac Radiol*. **28** (6): 357-363. doi: 10.1038/sj/dmfr/4600485.
22. Jadu F, Jan A. (2015). "Incidental findings on panoramic radiographs for pre-extraction assessment of third molars". *Asian J Sci Technol*. 6: 1539-1543. doi: 10.9790/0853-1707035459
23. Vallo J, Suominen-Taipale L, Huumonen S, Soikkonen K, Norblad A (2010). "Prevalence of mucosal abnormalities of the maxillary sinus and their relationship to dental disease in panoramic radiography: results from the Health 2000 Health Examination Survey". *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. **109** (3): e80-e87. doi: 10.1016/j.tripleo.2009.10.031. PMID: 20219592
24. Kuhlberg AJ, Norton LA (2003). "Pathologic findings in orthodontic radiographic images". *Am J Orthod Dentofacial Orthop*. **123** (2): 182-184. doi: 10.1067/mod.2003.4. PMID: 12594425
25. Saberi AE, Ebrahimipour S (2016). "Evaluation of developmental dental anomalies in digital panoramic radiographs in Southeast Iranian Population". *J Int Soc Prev Community Dent*. **6** (4): 291. doi: 10.4103/2231-0762.186804. PMID: 27583215
26. Onyeaso CO, Onyeaso AO (2006). "Occlusal/dental anomalies found in a random sample of Nigerian schoolchildren". *Oral Health Prev Dent*. **4** (3): 181-186. PMID: 16961026.
27. Pallikaraki G, Sifakakis I, Gizani S, Makou M, Mitsea A (2020). "Developmental dental anomalies assessed by panoramic radiographs in a Greek orthodontic population sample". *Eur Arch Paediatr Dent*. **21** (2): 223-8. doi: 10.1007/s40368-019-00476-y. PMID: 31494863
28. Backman B, Wahlin YB (2001). "Variations in number and morphology of permanent teeth in 7-year-old Swedish children". *Int J Paediatr Dent*. **11** (1): 11-17. doi: 10.1046/j.1365-263x.2001.00205.x. PMID: 11309867
29. Chattopadhyay A, Srinivas K (1996). "Transposition of teeth and genetic etiology.". *Angle Orthod*. **66** (2): 147-152. doi: 10.1043/0003-3219(1996)066<0147:TOTAGE>2.3.CO;2. PMID: 8712493
30. Hatzoudi M, Papadopoulos MA (2006). "Prevalence of tooth transposition in Greek population". *Hellenic Orthod Rev*. **9** (1): 11-22.
31. Papadopoulos MA, Chatzoudi M, Kaklamanos EG (2010). "Prevalence of tooth transposition: a meta-analysis". *Angle Orthod*. **80** (2): 275-285. doi: 10.2319/052109-284.1. PMID: 19905852
32. Yılmaz HH, Turkkahraman, Sayın H (2005). "Prevalence of tooth transpositions and associated dental anomalies in a Turkish population". *Dentomaxillofac Radiol*. **34** (1): 32-35. doi: 10.1259/dmfr/57695636. PMID: 15709103

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