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Panoramik Radyograflar İnterproksimal Çürük Tanısında Ne Kadar Kullanışlıdır? Diş Hekimliği Öğrencileri ve Diş Hekimleriyle Yapılan Bir Çalışma

How Available are Panoramic Radiographs in the Diagnosis of Interproximal Caries? A Study with Dental Students and Dentists

Caries Diagnosis Using Panoramic Radiographs

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Panoramik Radyograflar İnterproksimal Çürük Tanısında Ne Kadar Kullanışlıdır? Stajyer Diş hekimleri ve Diş Hekimleri ile Yapılan Bir Çalışma

How Available are Panoramic Radiographs in the Diagnosis of Interproximal Caries? A Study with Trainee Dentists and Dentists

Caries Diagnosis Using Panoramic Radiographs

ÖZET

Amaç: *Panoramik radyografların interproksimal çürük tanısında bitewing radyograflar olmaksızın kullanılabilirliğinin araştırılması, ayrıca stajyer diş hekimleri ve diş hekimlerinin panoramik radyograflarda interproksimal çürük tanısındaki performanslarının karşılaştırılması amaçlanmıştır.*

Yöntem: *Çalışmaya Erciyes Üniversitesi Diş Hekimliği Fakültesinde eğitim gören 20 dönem 4, 20 dönem 5 öğrencisi ve 20 diş hekimi dahil edildi. Çalışmada 2020 yılı içerisinde endikasyon dahilinde aynı gün içerisinde hem panoramik hem de bitewing grafileri alınmış 11 bireyin görüntüleri kullanıldı. İlk olarak üç Ağız, Diş ve Çene Radyolojisi araştırma görevlisi tarafından radyograflar değerlendirildi ve bitewing radyograflarda posterior dişlerin interproksimal yüzeylerindeki çürükler ortak bir görüşle kaydedildi. İkinci olarak da çalışmaya katılmayı kabul eden katılımcılar sadece panoramik radyografları değerlendirerek premolar ve molar dişlerin arayüzlerinde çürük olarak değerlendirdikleri lezyonları derinliklerine göre "0", "1", "2" ve "3" olarak hazırlanan forma kodladılar. İstatistiksel analizler SPSS v.22 yazılımı ile gerçekleştirildi.*

Bulgular: *Dişlerin çürüğün varlığı ya da yokluğu açısından doğru değerlendirme bakımından en başarılı olanlar pratisyen diş hekimleriydi (%80,52). Bunu dönem 5 (%67,29) ve dönem 4 (%60,12) öğrencileri takip etmekteydi. (p<0,001). Çürüklerin derinliğine göre yapılan değerlendirmede ise, tüm derinliklerde yine diş hekimlerinin başarı oranı daha yüksekti (p<0,05). Her üç grupta da çürük pulpaya yaklaştıkça tespit edilmesindeki başarı oranı artmaktaydı. En az başarı oranları ise, her üç grup için "1" tipinde bulundu. Çürük bulunan yüzeyler içerisinde hatalı teşhis oranı en yüksek olan bölge üst premolar bölgesiyken, en başarılı bölge ise alt molar bölgeydi.*

Sonuç: *Panoramik radyograflar arayüz çürüklerinin değerlendirilmesinde, bitewing radyograflar kadar olmasa da yararlı olabilir. Bunda yıllar içerisinde çok sayıda radyograf değerlendirmenin etkisi yadsınamaz.*

Anahtar Kelimeler: *İnterproksimal çürük, bitewing radyografi, panoramik radyografi*

ABSTRACT

Purpose: *It was aimed to investigate the usability of panoramic radiographs without bitewing radiographs in the diagnosis of interproximal caries and to compare the performance of trainee dentists and dentists in the diagnosis of interproximal caries on panoramic radiographs.*

Material and Method: *20 4th grade, 20 5th grade students studying at Erciyes University Faculty of Dentistry and 20 general dentists were included in the study. In the study, images of 11 individuals who had both panoramic and bitewing taken on the same day within the indication in 2020 were used. Initially, radiographs were evaluated by three Oral, Dental and Maxillofacial Radiology research assistants, and caries on the interproximal surfaces of posterior teeth were recorded with a consensus on bitewing radiographs. Second, the participants who agreed to participate in the study evaluated only the panoramic radiographs and coded the lesions at the interfaces of the premolar and molar teeth as "0", "1", "2", and "3" according to their depth. Statistical analyzes were performed with SPSS v.22 software.*

Results: *Dentists were the most successful in terms of correct evaluation of teeth in terms of the presence or absence of caries (80.52%). This was followed by class 5 (67.29%) and class 4 (60.12%) students. (p<0.001). In the evaluation made according to the depth of caries, the success rate of dentists was higher at all depths (p<0.05). In all three groups, the success rate in detection increased as the caries approached the pulp. The least success rates were found in the "1" type for all three groups. The maxillary premolar area had the highest rate of misdiagnosis among the carious surfaces, whereas the mandibular molar region had the best success rate.*

Conclusion: *Panoramic radiographs can be beneficial in evaluating interface caries, although not as much as bitewing radiographs. The cumulative effect of many radiological assessments throughout the years cannot be disputed.*

Keywords: *Interproximal caries, bitewing radiography, panoramic radiography, caries detection*

Introduction

Dental caries is a considerably prevalent condition that affects billions of people all over the world. Early diagnosis of these demineralized lesions, either clinically or radiologically, decreases the requirement for restorative treatment. This contributes to both patient comfort and the reduction of costly treatments in the healthcare field.[1] Bitewing radiographs are used to detect cavitated interface caries in multiple maxillary and mandibular teeth, secondary caries under restoration, and lesions in dentin. Detection of initial lesions without cavitation is essential for the application of microinvasive or noninvasive treatments.[2]

Areas of demineralization appear as a radiolucent region on the radiographic image. Because demineralized areas of the tooth do not absorb as many photons as normal dental hard tissues during exposure. The classic shape of an early radiolucent enamel lesion is a triangle with a broad base on the tooth surface, but other appearances such as nicks, spots, bands, or thin lines are also common.[3] Lesions involving interproximal surfaces are most found at or below the point of contact.[4] The frequency of the contact site may influence the development of the caries lesion.[5]

The level of cavitation on clinically inaccessible interproximal surfaces can be difficult to determine, and a thorough visual examination by the examining dentist has been shown to diagnose only about 12-50% of cavitated surfaces.[6] In comparison to assessment by visual examination alone, radiography has been shown in several studies to offer significant diagnostic value for the determined of carious demineralization on interproximal surfaces in both adults and children.[7] Although there are differences between the radiographic interpretations of caries lesions by observers, radiography is still the most recommended adjunctive method in the diagnosis of interproximal caries lesions in daily clinical practice.[8] Intraoral radiographs, whether film-based or digital image receptor-based, are the most used imaging modality to detect carious lesions.[9,10]

However, as it is known, the whole world faced a major epidemic in 2020, and the World Health Organization (WHO) declared a pandemic on March 11, 2020, due to the infection of SARS-CoV-2, which causes COVID-19.[11] The American Dental Association has offered interim advice during the COVID-19 outbreak by advising against or limiting intraoral radiography.[12] Dental panoramic radiography emerged as the most used imaging technique during this period.[13]

In this study, it was aimed to investigate the use of panoramic radiographs without bitewing radiographs in the diagnosis of interproximal caries for similar extraordinary situations that may occur in the future and to compare the success rates of trainee dentists and dentists in the diagnosis of interproximal caries on panoramic radiographs.

Materials and Methods

20 4th grade, 20 5th grade, and 20 general dentists working in private and public practice in Kayseri province were involved in this study. Images of 11 people who applied for various reasons in 2020 to the Department of Oral and Maxillofacial Radiology at Erciyes University Faculty of Dentistry and whose panoramic and bitewing radiographs were obtained on the same day within the indication were utilized in the study. The criteria for selecting the radiographs used in the study are as follows:

1. Radiological records are available and diagnostically sufficient

2. Having medical anamnesis records for the patient whose radiograph is being used

3. No radiographic error

4. In addition to the panoramic radiograph of the patient, there are diagnostically sufficient bilateral bitewing radiographs taken on the same day.

Individuals who had a previous restoration of their teeth, dental and/or skeletal anomalies, periodontal problems (vertical/horizontal bone loss), and disagreement about caries status on bitewing radiographs were not included in the study. This study was approved by the Erciyes University Clinical Research Ethics Committee (Protocol no: 2022/571).

All panoramic radiographs were obtained with the device OP-200D (Instrumentarium Dental, Tuusula/ Finland), and all bitewing radiographs were obtained with Kodak Care/Stream 2100 DC model device with the direction of the central beam +10 degrees vertical angle. Imaging parameters were 70 kVp, 8 sexposure time, and 10 mA for panoramic radiograph, 60 kVp, 0.16 sexposure

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time, and 7 mA for bitewing radiograph.

First, panoramic and bitewing radiographs were recorded on the work computer (Acer Aspire V15, (Taiwan), 15.60 inches, 1920 x 1080 pixels) in jpeg format via the MedData Med2016 V4 hospital automation system. Panoramic and bitewing radiographs were evaluated by three oral, dental, and maxillofacial radiology research assistants in a standard dark room. The caries observed on the interproximal surfaces of the posterior teeth on bitewing radiographs were determined and recorded with a common decision.

According to Lian et al.[14] interproximal caries were divided into 4 groups as follows:

0: No radiolucency

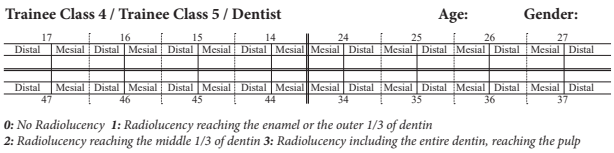
1: Radiolucency reaching the enamel or the outer 1/3 o f dentin

2: Radiolucency reaching the middle 1/3 of dentin

3: Radiolucency including the entire dentin, reaching the pulp (Figure I)

Figure I. *a: Right posterior bitewing radiograph, black star; caries type expressed as "0", white star; caries type expressed as "3"*
b: Left posterior bitewing radiograph, white arrow; caries type expressed as "1", black arrow; caries type expressed as "2"
c: Panoramic image of the patient with bitewing radiographs in the figure

In 11 panoramic radiographs, there were 352 surfaces. It was determined by the consensus of the research assistants that there were caries on 100 surfaces on bitewing radiographs. Panoramic radiographs were shown to the participants for caries assessments. Participants coded caries they observed on the mesial and distal surfaces of the posterior teeth as "0", "1", "2" and "3" on forms (Figure II).



0: *No Radiolucency* ***1:*** *Radiolucency reaching the enamel or the outer 1/3 of dentin*
2: *Radiolucency reaching the middle 1/3 of dentin* ***3:*** *Radiolucency including the entire dentin, reaching the pulp*

Figure II. *The image of the form in which the observers recorded the depth of the caries.*

Statistical Analysis: Statistical analyses were performed using IBM SPSS Statistics v 22.0 software. Descriptive statistics are given as the number of patients (N), percent (%), and mean ± standard deviation ($\bar{x}$ ± Sd). The Kruskal-Wallis test was used to evaluate the significant difference between the mean ages of trainee dentists and general dentists. The Pearson chi-square test was used to determine whether there was a difference between trainee dentists and dentists in terms of gender. The Shapiro-Wilk test was used to determine the normal distribution of the data. The ANOVA test was used to evaluate the rate of correct recognition of interproximal caries between groups. The Pearson chi-square test was used to compare the correct determination of caries depth between groups. The statistical significance level was accepted as $p<0.05$.

Results

The mean age of the dentists included in the study was 30.10±3.21, the mean age of 4th grade trainee dentists was 22.60±0.96, and fifth-class trainee dentists was 23.50±0.70. There was a statistically significant difference between the groups in terms of mean age, since the mean age of the general dentists was higher than that of the trainee dentists ($p<0.001$). There was no significant difference between the three groups in terms of gender distribution ($p=0.585$) (Table I).

Table I. Evaluation of mean age and gender distribution according to study groups

		G Dentist	4th grade	5th grade	P
Mean Age	$\bar{x}$ ± Sd	30.10±3.21	22.60±0.96	23.50±0.70	<0.001a*
Gender	N (%)				
Male		12 (%60)	8 (%40)	12 (%60)	0.585[b]
Female		8 (%40)	12 (%60)		

$\bar{x}$, Mean; Sd, Standard deviation; N, Number; a, Kruskal-Wallis test; b, Pearson chi-square test;
*, p<0,05.

In general, when the presence or absence of caries was taken into consideration, the success rate was 80.52% for dentists, 60.12% for 4th grade trainee dentists, and

67.29% for 5th grade trainee dentists. In all 3 groups, the success rate in detecting the presence of caries increased in direct proportion to the depth of caries. This difference was statistically significant (p<0.001) (Table II).

Table II. Evaluation of success rates of dentists, fourth-grade trainee dentists, and fifth-grade trainee dentists in detecting caries on panoramic radiographs

	G Dentist	4th grade	5th grade	P
Presence of Caries (%)	76.24	52.25	61.16	<0.001*
Absence of Caries	82.23	63.25	69.73	<0.001*
Total	80.52	60.12	67.29	<0.001*

*, p<0,05.

When the success rates in detecting carious surfaces were evaluated by region, the most successful region in the entire study group was the mandibular molar region (82.47%). This was followed by the maxillary molar region (71.41%) and the mandibular premolar region (66.14%). The region where caries were detected with the lowest success rate on panoramic radiographs was the maxillary premolar region (58.12%).

Dentists were found to have the highest success rate in determining the depth of carious lesions. The group with the lowest success rate in this regard was fourth-class trainee dentists. There was a statistically significant difference between the participants in terms of the success rate of determining the depth of caries lesions. (0, p<0.001; 1, p=0.003; 2, p<0.001; 3, p<0.001) (Table III).

Table III. Evaluation of success rates of dentists, fourth-grade trainee dentists, and fifth-grade trainee dentists in determining the depth of caries on panoramic radiographs

		G Dentist	4th grade	5th grade	P
0	(%)	82.23	63.25	69.73	<0.001*
1		50.52	32.27	44.90	0.003*
2		70.58	41.17	50.58	<0.001*
3		90.58	67.05	77.64	<0.001*

0, No radiolucency; 1, Radiolucency reaching the enamel or the outer 1/3 of dentin; 2, Radiolucency reaching the middle 1/3 of dentin; 3, Radiolucency including the entire dentin, reaching the pulp; *, p<0,05.

Discussion

Evaluation of dental caries is the most frequently performed procedure by dentists in daily practice. The aim of dentists should be to prevent expensive restorative treatments by detecting caries before cavitation occurs and treating them with microinvasive or noninvasive methods. In cases where cavitation is present but cannot be detected in clinical examination, they resort to auxiliary examination methods. When necessary, bitewing radiographs are used to support panoramic radiographs in order to ensure that caries at the interfaces are not missed.[14] Bitewing radiographs are a widely accepted radiographic method in the diagnosis of interproximal caries.[15,16] In addition to these techniques, there are other methods to diagnose interproximal caries. Among them are visual inspection, laser fluorescence, fiber optic transillumination, and optical coherence tomography.[17]

In the early part of the COVID-19 outbreak, minimal use of intraoral radiographs was recommended both to protect the radiologist and to avoid the risk of cross-infection between patients, given that they can cause gagging and coughing during administration.[18,19] In line with these recommendations, our inspiration for this study was how successful both general dentists and trainee dentists were in diagnosing caries with only panoramic radiographs within these limitations. We believe that the results of the study will contribute to the protocol of taking intraoral radiographs in the case of a COVID-19 pandemic or a possible new pandemic in the future.

In this study, when the carious surfaces were evaluated regionally, the maxillary premolar region was the most error-prone region, and the most successful region was the mandibular molar region. This may be caused by the characteristic superposition of the interproximal surfaces of the premolars on panoramic radiographs.[3] Akkaya et al.[20] reported that interproximal caries in the molar region had a higher success rate in diagnosis than interproximal caries in the premolar region. Results of the study by Akarslan et al.[21] also supported this conclusion. They also stated that panoramic radiographs are not suitable for the diagnosis of interproximal caries in the premolar region. This study showed results consistent with their studies.

It has been reported in the literature that the depth of carious lesions influences the diagnosis of caries. On radiographs, caries localized in the internal half of dentin are diagnosed more frequently than caries localized in enamel. It is stated that the person needs a little luck in the detection of small interproximal caries.[22] In this study, it was seen that the rate of caries detection on panoramic radiographs increased in direct proportion with the depth of caries among dentists and two groups of trainee

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dentists. In all three groups, the caries type defined as "3" (deepest caries lesion), was detected with higher success rates. The type of caries expressed as "1" had the lowest success rate in diagnosis, as expected.

When the success rates in diagnosis were compared between the groups, the dentist's group had the highest rate of success. This was followed by 5th grade trainee dentists and then 4th grade trainee dentists. Although the relationship between the rate of success in diagnosis with age is not significant among participants, the weak positive correlation with age may have been caused by the abundance of radiographs observed by the dentist over the years and clinical experience. The success rates were found to be higher, as expected, since fifth-class trainee dentists had more opportunities for radiograph examination and treatment in the clinic than fourth-class trainee dentists. (Figure III)

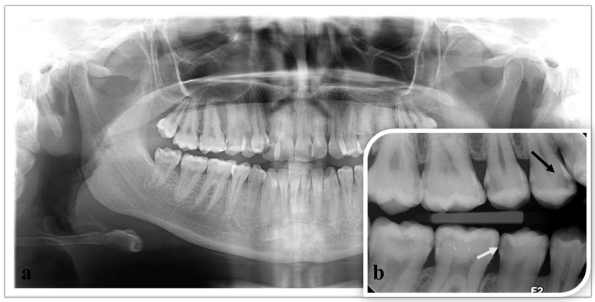

Figure III. *a: Panoramic image of the patient with bitewing radiographs in the figüre*
b: Right posterior bitewing radiograph, black arrow; approximal caries that is undetectable due to superposition, white arrow; approximal caries that is detected by dentists but cannot be detected by trainee dentists.

In studies evaluating the diagnostic accuracy of panoramic and bitewing radiographs and interproximal caries in the literature, bitewing radiographs were found to be superior to panoramic radiographs.[21-23] However, it has also been stated that panoramic radiographs may be useful in cases where bitewing radiographs cannot be obtained, such as vomiting and gag reflex.[24]

Yet to our knowledge, this is the first study on determining the success rate of carious depth detection on panoramic radiographs with the contribution of trainee dentists. This can be postulated as a strong part of this study. The limitations of this study can be given that the number of participants making evaluations is low and that the images are presented to participants as pictures in "JPEG" format. The failure of participants to use features such as contrast adjustment, zooming in/out, and taking the negative of the image in caries detection, which would be advantageous over a radiograph recorded as a picture, may have affected the results. There are contradictory opinions in the literature on this issue. Some studies have reported that contrast enhancement and other features that improve the image increase the accuracy of the diagnosis of caries.[25,26] On the other hand, some studies have argued that this does not affect the success in diagnosis.[27,28]

Conclusion

Although panoramic radiographs are not as successful as bitewing radiographs in detecting enamel or superficial dentin lesions, they can be useful in the diagnosis of interproximal caries, especially when there is a risk of cross-infection, or it is not possible to take intraoral radiographs.

Conflict of Interest

The authors declare no conflict of interest.

This study was presented in the form of an oral presentation at the "4th International Congress of the Society of Oral Diagnosis and Maxillofacial Radiology" between October 19-23rd 2022. The oral presentation was published as an abstract in the special issue of the congress in the journal "European Annals of Dental Sciences".

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