

Common Positioning Errors in Digital Panoramic Radiographies Taken In Mashhad Dental School

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Abstract

Introduction: The present study was aimed at evaluating common positioning errors on panoramic radiographs taken in the Radiology Department of Mashhad Dental School. **Materials and methods:** The study sample included 1,990 digital panoramic radiographs taken in the Radiology Department of Mashhad Dental School by a Planmeca Promax (Planmeca Oy, Helsinki, Finland), during a 2-year period (2010–2012). All radiographs, according to dentition and sex, were evaluated for positioning errors. **Results:** There were 1,927 (96.8%) panoramic radiographs with one or more errors. While the number of errors in each image varied between one and five, most images had one error (48.4%). The most common error was that the tongue was not in contact with the hard palate (94.8%). "Open lips" was an error not seen in any patients. **Conclusions:** positioning errors are common in panoramic radiographies. The most common error observed in this study was a failure to place the tongue on the palate. This error and the other errors reported in this study can be reduced by training the technicians and spending little more time for patient positioning and more effective communication with the patients.

Key words: panoramic radiography; diagnostic imaging; patient positioning; quality improvement.

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Introduction

Panoramic radiography is a simple extra oral radiographic technique that allows visualization of all maxillary and mandibular areas on one radiographic film, which is a valuable adjunct to routine diagnostic procedures. (1) It is also one of the most common radiographic techniques in dentistry and it has achieved a special position as a diagnostic tool since its introduction in the early 1960s. This type of radiography is a popular diagnostic method and is used alone or with other radiographic techniques. (2)

Panoramic radiographs are clinically useful for diagnosing the conditions that require a wide coverage of the jaws, including traumas, position of the third molars, extensive disease entities, identification of suspected large lesions, tooth development (especially in the mixed dentition period), residual teeth or roots (in edentulous patients), and congenital/developmental anomalies. Such cases do not require the high resolution and great detail observed on intraoral images. (1)

Radiographic images of the entire maxillofacial structure can provide good quality with low radiation doses. Patient comfort and usability, even in patients with limited mouth opening, is another benefit.¹ If low quality images are produced, there may be a reduction in diagnostic value, which could lead to inappropriate treatments. The low quality observed in some images is not due to the inherent limitations of these techniques, but are a result of operator or patient errors during the radiography procedures. Panoramic radiography images may contain opaque and lucent areas from the reflection of soft tissue structures in the study area, as well as air paths that affect the actual structures. In cases in which the diagnostic quality is unsatisfactory, the value of the radiographic images decreases and they should be repeated, which results in increased radiation exposure, higher costs and wasted time. (3) This emphasizes the importance of accuracy in the preparation process of radiography film. Preparing and placing the patient in the perfect position is necessary for a readable, accurate and errorless radiographic image. (4)

The aim of this study was to evaluate the quality of panoramic radiographic images and to find common errors that can be avoided.

Materials and methods

This study was approved by the Ethics Committee of Mashhad University of Medical Sciences (The code IR.MUMS.REC.1393.247). In this study, we used simple random sampling to select and evaluate 1,990 digital panoramic radiographs of our archival images that were obtained over a 2-year period (December

2010–December 2012) with a Planmeca Promax (Planmeca Oy, Helsinki, Finland) panoramic radiography unit. All radiographs were prepared in the Radiology Department of Mashhad Dental School by an experienced oral and maxillofacial radiologist [A.B.]. The minimum and maximum ages of patients in this study were 5 and 88, respectively. The persons who were under 12 years old and had both deciduous and permanent teeth in oral cavity together were considered as mixed dentition group. The cases included 678 men and 1,312 women. Radiographs were evaluated according to the inclusion and exclusion criteria outlined below.

Inclusion criterion was patients with permanent or mixed dentition. Exclusion criterion was patients with severe skeletal deformities or considerable asymmetry based on their records, those without teeth and any extensive bone pathology that prevented proper adjustment of the patient's head.

All radiographs were evaluated by one radiologist [A.B.]. Examined errors consisted of patient with a head forward or backward positioning, head turning or tilting, a chin low or high positioning, bending the neck, not positioning the chin in the chin rest, the distance between the tongue and palate, an open mouth and movement of the patient's head. The intra-observer error was measured by reviewing random samples of 100 ($\approx 5\%$) panoramic images after a 2-week interval. A paired *t*-test was applied for the analysis of both readings. All TIFF format panoramic files were examined on a laptop (HP 255 G5 Notebook, 15.6" diagonal HD SVA anti-glare slim LED-backlit [1366 x 768]) in a semi-darkened room. The intra-observer error was measured by reviewing random samples of 100 ($\approx 5\%$) panoramic images after a 2-week interval. A paired *t*-test was applied for the analysis of both readings. The errors examined per patient were put in a pre-designed Excel file. Then, the Excel data were moved to the PASW 18 program. Tables and graphs appropriate to the PASW 18 were then drawn. For data analysis, the χ^2 test was used. A $p < 0.05$ was considered statistically significant.

Results

In this study, 1,990 patients (612 males and 1312 females) who were referred for panoramic radiography in Mashhad Dental School were selected. Patients ranged from 5 to 88 years with the mean age of 33.55 ± 15.26 years for the study population. The mean and standard deviation of age were 34.41 ± 15.80 and 33.10 ± 14.95 for males and females, respectively.

Re-examining 100 panoramic radiographs enabled the measurement of the intra-observer reproducibility. The difference between the number of positioning

errors on the first and second readings was not significant ($p = 0.19$).

Given that the clients for dental services were mostly women, the women's group had the number of participation two times more than the men's group. For comparison of the average ages of the two studied sex groups, the ages for both sexes, in terms of a normal distribution, were evaluated. A one-sample Kolmogorov-Smirnov test showed that the ages of the two sexes were not distributed normally ($p < 0.001$). Due to the non-normal distribution of ages in both sexes, a Mann-Whitney test was used to compare the mean rank of ages in both sexes. The results showed that the ages of the two sex groups had no significant differences ($p = 0.089$).

Comparing positioning errors between the mixed and permanent dentition groups

Due to the smaller anatomical structures in children than in adults, and regarding the fact that they were less cooperative, a comparison between the errors in the permanent and mixed dentition groups was carried out. Table 1 provides the number and percentage of errors observed in the two groups. As shown in the table, most errors can be attributed to the distance between the tongue and palate, followed by errors related to the high positioning of the chin. Patients were evaluated for the possibility of various errors, and patients with no errors were considered as error free. Findings showed that only 63 (2.3%) of the 1,990 patients had no positioning errors.

According to the previously mentioned data, the frequency of a head forward or backward position, turning or tilting of the head to one side, not positioning the chin on the chin rest, and movement or reclining of the patient were the most common errors in patients with permanent teeth. In patients with mixed dentition, the most common errors were excessive low or high chin positioning and distance between tongue and palate. (Fig. 1-3)



Figure 1. "Too far forward" positioning error was detected in this panoramic radiography.



Figure 2. There are two errors in this panoramic image: the head "too far backward" and the "chin high positioning" errors.



Figure 3. The errors that are seen in this panoramic radiography are "the distance between tongue and palate" and "turning the head to the right side"

Presence or absence of errors in the permanent and mixed dentition groups

As shown in Table 2, patients with mixed dentition were more susceptible to errors than those with permanent teeth.

Comparison of patient positioning errors in both sexes

In Table 3, the number and percentage of each error in the two sex groups is shown. According to the table, the maximum errors were the distance between the tongue and palate followed by a high chin position. An open lips error was not observed in any patients.

The frequency of a patient's head forward or backward positioning, turning or tilting of the head to one side, distance between tongue and palate, and movement or reclining of the patient were more common in males. In women, not positioning the chin on the chin rest and having the patient's head in a forward position were more common than in men. This Table shows that no distance between tongue and palate was the most common error observed in patients. After that, a high chin position had the most prevalence. Also, none of the patients had their lips opened.

Presence or absence and total frequency of errors in both sexes

Table 4 shows that the risk of presence of error in men was slightly higher than in women. This table shows that radiographs with only one error had the highest frequency while radiographs with five errors had the lowest frequency among all samples.

Different positioning errors accompanied each other

Because the distance between tongue and palate had the maximum number of errors in this study, its accompaniment with other errors was measured. The χ^2 test showed that the distance between tongue and palate error was accompanied with the head turning to the right error ($\chi^2 = 5.44, p = 0.01$). (Table 5)

Table 1. Frequency of errors in each of studied groups

Error	Permanent dentition Number (%)	Mixed dentition Number (%)
Forward position	44(2.2)	1(0.05)
Backward position	185(9.2)	2(0.1)
Turning to right	94(4.7)	1(0.05)
Turning to left	67(3.3)	1(0.05)
Tilting to right	24(1.2)	0(0)
Tilting to left	8(0.4)	0(0)
Chin low positioning	49(2.4)	3(0.15)
Chin high positioning	635(31.9)	45(2.2)
Bending the neck	36(1.8)	2(0.1)
Not in chin rest	93(4.6)	2(0.1)
Distance between tongue and palate	1776(89.2)	111(5.5)
Open lips	0(0)	0(0)
Movement of head	2(0.1)	0(0)

Table 2. Presence or absence of error in two dentition types

Type of dentition		Number (%)
Permanent dentition	With error	1815 (96.7)
	Error-free	62 (3.3)
Mixed dentition	With error	112 (99.1)
	Error-free	1 (0.9)

Table 3. Frequency of errors in both sexes

Error	Male Number (%)	Female Number (%)	Total Number (%)
Forward position	11(1.6)	34(2.6)	45(2.3)
Backward position	116(17.1)	71(5.4)	187(9.4)
Turning to right	45(6.6)	50(3.8)	95(4.8)
Turning to left	28(4.1)	40(3.0)	68(3.4)
Tilting to right	19(2.8)	5(0.4)	24(1.2)
Tilting to left	5(0.7)	3(0.2)	8(0.4)
Chin low positioning	25(3.7)	27(2.1)	52(2.6)
Chin high positioning	242(35.7)	438(33.4)	680(34.2)
Bending the neck	18(2.7)	20(1.5)	38(1.9)
Not in chin rest	32(4.7)	63(4.8)	95(4.8)
Distance between tongue and palate	645(95.1)	1242(94.7)	1887(94.8)
Open lips	0(0)	0(0)	0(0)
Movement of head	2(0.3)	0(0)	2(0.1)

Table 4. Number of errors in studied population according to sex

sex	Number of errors	Number (%)
Male	0	20(3.0)
	1	324(47.8)
	2	240(35.4)
	3	78(11.5)
	4	14(2.0)
	5	2(0.3)
Female	0	43(3.3)
	1	638(48.6)
	2	468(35.7)
	3	143(10.9)
	4	20(1.5)
	5	0

Table 5. accompaniment of "distance between tongue and palate" error with "turning head to right side"

Error	Turning to right		Total
	No	Yes	
Distance between tongue and palate	No	103	0
	Yes	1792	95
Total	1895	95	1990

Discussion

Panoramic radiography is prone to various errors that can affect the validity of its information. This has been confirmed by the results of the current study, such that only 63 out of the 1,990 samples were error-free images.

In this study, all errors were related to the position of the patient and each error was evaluated according to the sex and dentition group of the patients. All radiographs were prepared by an oral and maxillofacial radiologist with 7 years of experience. The percentage of radiographs without an error was 2.3%. In various studies, 0.8% to 37.61% of the radiographs were reported error-free. (3, 5-13)

In the present study, the most frequent samples were those with only one error, while in studies by Pretz et al. (8) and Granlund et al. (9), groups with two errors were the most frequent. These differences in results can be attributed to different types of errors in this study compared to other studies.

In this study, the most common error was related to the distance between the tongue and palate (the palatoglossal space). This finding has also been reported in some other studies. (6, 7, 9-10, 12, 14, 15) In the study conducted by Bissoon and colleagues, this finding was also reported in images from dental clinics. However, in samples collected from private offices, the most common error was head turning. The reason for this difference could be due to assigning head turning and tilting to the same category. (7) This difference was also seen in the study by Kaviani and colleagues, (3) which could be drawn for the same reason. In a study by Glass et al., (13) the highest error reported was a high chin position. This difference can be justified with the small statistical population (75 patients) and the study on the edentulous patients. A high frequency of distance between tongue and palate error is often due to a lack of proper communication

between patients and operators, and a lack of sufficient explanation on how to place the tongue, which can lead to misinterpretations by the patient.

In present study, the frequency of each error was calculated separately for both sex and dentition groups, which has rarely been investigated. It is believed that the error rate in panoramic radiographs among the younger age group (patients with mixed dentition) is higher. This is because of the inability of these patients to remain relaxed and motionless during the radiography process and the lack of adequate communication between the patient and the operator.

Our study revealed that the frequency of having a patient's head in a forward or backward position, turning or tilting the head to one side, not positioning the chin on the chin rest, and movement or reclining are higher among patients with permanent teeth compared to those with mixed dentition. These findings, except in the case of an excessive forward head position, as well as patient motion during the exposure, were similar with the findings by Pretz et al. (8) Differences could be a result of fewer samples in the current study.

In this study, for the first time, the results have been reported based on sex and dentition. The number of samples was higher compared to most other studies. By collecting samples from only one centre, the difference in devices, as well as differences in operator skills, did not affect the results.

The present study, as one of its limitations, suggests that, in future studies, different centres with a greater variety of devices and operator skills be investigated to examine the impact of these factors on the results.

Conclusions

In conclusion, positioning errors are common in panoramic radiographies. Based on our findings, the most common positioning error was "distance between

tongue and palate" that can be reduced by spending little more time for better communication with the patients and more detailed descriptions (specially in children). Training the technicians to diagnose the errors and avoid or resolve them can also reduce frequency of errors. Diagnostic value of panoramic radiography is decreased when errors are occurred. So awareness of common errors and attempt to avoid them can improve quality of images and consequently, the need for repeat radiography and the patient's absorbed dose is reduced.

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