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Original Article

Positioning Errors in Panoramic Images Based on the Dentition Type of Patients Referring to the Oral and Maxillofacial Radiology Department of Tabriz Dental School During 2017-2018

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Abstract

Background: Panoramic imaging is a technique to create images of facial structures. Various factors affect the preparation of a high-quality and proper panoramic image such as the patient's proper position. The aim of this study was to investigate positioning errors in panoramic images based on the dentition type of patients referring to THE oral and maxillofacial radiology department of Tabriz Dental School.

Methods: This cross-sectional study was conducted in the Radiology Department of Tabriz Dental School in 2017-2018. The dentition of patients (primary, mixed, permanent, and complete edentulous) was determined by radiography. Accordingly, 410 radiographs per group (1640 samples) were selected from the archives of the Radiology Department by simple random sampling method. One radiologist evaluated all the images in the same condition and in a semi-dark room, in a 21-inch DELL monitor, regarding the presence of each of the positioning errors. Radiographs that were repeated due to positioning errors and poor diagnostic quality were classified as unacceptable radiographic images.

Results: In the primary, mixed, permanent, and edentulous dentitions, not attaching the tongue to the palate was the error with the highest frequency in the radiographs, with 50.4%, 65.6%, 64.3%, and 64.8%, respectively. The presence of two errors with 563 radiographs (34.3%) had the highest frequency, and 123 radiographs (7.5%) were free of errors. Primary dentition with 95 radiographs (23.2%) had the highest unacceptable radiographs, and edentulous dentition with 29 radiographs (7.1%) had the lowest unacceptable radiographs. Furthermore, the chi-square test indicated that this finding was statistically significant ($P < 0.001$).

Conclusions: Positioning error has a high prevalence in radiographic images, the most common of which is not attaching the tongue to the palate during radiography. In the primary dentition period, the number of acceptable radiographs was less than in the other periods.

Keywords: Patient positioning, Panoramic radiography, Dentition

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Introduction

Panoramic imaging is a technique to create images of facial structures, including maxillary and mandibular dental arch and their supporting structures. In panoramic radiography, the radiation source and the image receiver spin around the patient's head and create a focal trough curve. Objects located in the focal trough are displayed clearly, but the objects located in the front or behind this focal trough are faded and not visible (1-3). Various factors affect the preparation of a high-quality and proper panoramic images such as the performance of the operator, the imaging apparatus, the film processing equipment, and the patient's proper position. Any change in the quality of the radiography causes the inability to interpret, misinterpretation, and ultimately wrong diagnosis and treatment plan. In addition, in cases where our goal for interpretation is not provided, there will be a need for re-radiography, which will result in additional radiation, causing harm to the dentist, patient, and possibly other personnel. It also wastes time and money.

The patient's proper position is one of the factors beyond the authority of the operator and can play an important role in the preparation of an appropriate image. Moreover, if the patient is not well acquainted with the radiography process, the risk of error will increase due to the patient's unawareness (1,4,5).

Various studies in different countries of the world have investigated the common errors in panoramic radiography and reported error rates from around 27.5% to about 94%. Pandey et al reported 27.5% of panoramic radiography errors in Nepal, with 16.2% of them being positioning errors (2). In a study by Dhillon et al (6), only 196 (11%) panoramic images were error-free. In Tabriz, in a study by Kaviani et al, 92.4% of the images had errors, 78% of which were errors due to the positioning of the patient (7). In Rasht, Mohtavipour et al reported the common errors in panoramic images to be 78.4%, 56.2% of which were related to the non-appropriate positioning of the tongue toward the palate (8). The presence of such high rates of errors in panoramic radiographic images necessitate further studies to better identify these errors and the factors affecting them. On the other hand, all of these studies have evaluated the common errors in the permanent dentition period and have not paid attention to the frequency of errors based on the dentition type of patient (edentulous, primary dentition period, mixed dentition period, and permanent dentition period). However, due to the anatomical differences in the oral cavity in different dentitions, the type and frequency of errors are expected to vary. For the first time, Peretz et al conducted a study titled "Common errors in digital panoramic radiographs of patients with mixed dentition and patients with permanent dentition", but they did not evaluate patients with primary dentition or complete edentulous (9). On the other hand, searching scientific resources and databases such as PubMed and Scopus indicated that, except for the study by Kaviani et al (7) in 2008, no novel studies have been conducted to evaluate errors in panoramic radiography images in Tabriz. Therefore, this study aimed to investigate positioning errors in panoramic images based on the dentition type of patients referring to the oral and maxillofacial radiology department of Tabriz Dental School. It is expected that the results of this study will be helpful in reducing the cost, the spent time, and additional exposure of patients, along with increasing the diagnostic accuracy for dentists and improving the working quality of radiology personnel.

Methods

This descriptive cross-sectional study was conducted in the Radiology Department of Tabriz Dental School in 2017-2018. All information about patients whose radiographic stereotypes were investigated in this study was kept confidential. The ethical issues of this study were in accordance with the Helsinki Declaration in 1975 and its subsequent amendment in 2002.

In this study,1640 stereotypes of panoramic radiography from the archives of the Radiology Department of Tabriz Dental School were selected by a simple random sampling method and were studied. In order to determine the sample size, using the results of the study by Peretz et al (9) and considering a 0.1 unit difference in mean of occurred errors in the two groups with mixed and permanent dentitions and a deviation of 0.73 and 0.87, respectively, 410 samples per group and 1640 samples, in general, were estimated.

Inclusion criteria were images of patients ranging from 4 to 70 years and images without device defects. Exclusion criteria included images of patients with trauma, a history of neoplasm, and any lesions observed in the jaw, and patients whose information (e.g., age and gender) was not recorded.

All panoramic images were prepared by the Dental X-ray System (RAYSCANα-P, South Korea) and in accordance with factory specifications (60-90 kVp, 50/60 Hz, 4-17 mA, and 14-second imaging duration) and using the Scanner 2.0.1 software by a trained technician. Images were prepared by an oral and maxillofacial radiologist who was not aware of the study goals.

The dentition of patients (primary, mixed, permanent, and complete edentulous) was determined by radiography. One radiologist evaluated all the images in the same condition and in a semi-dark room, in a 21-inch DELL monitor, regarding the presence of each of the positioning errors and entered them into the relevant checklist. The studied positioning errors were as follows: 1) Forward positioning of the patient. 2) Backward positioning of the patient. 3) The patient's head is twisted around the neck. 4) The patient's head is tilted around the neck. 5) The chin is raised higher. 6) Chin is tipped low. 7) The patient is not standing and is crouched. 8) The chin is not placed on the chin rest. 9) The bite guide is not used. 10) The patient does not attach his/her tongue to the palate. 11) Lips are open. 12) The patient moves during imaging. 13) The patient does not detach the metal objects.

Finally, radiographs that were repeated due to positioning errors and poor diagnostic quality were classified as unacceptable radiographic images, and the rest of the images were classified as acceptable. Then, the obtained data from the study were analyzed by descriptive statistics (frequency, percentage, and mean ± standard deviation), chi-square test, and SPSS version 17. In this study, a *P* value of less than 0.05 was considered statistically significant.

Results

The participants of this study comprised 850 (51.8%) females and 790 (48.2%) males (Table 1), and their average age is given in Table 2. As observed in Table 3, not attaching the tongue to the palate, openness of lips, and higher position of the chin are the most frequent positioning errors with 61.2% (1006 radiographs), 28.2% (464 radiographs), and 22% (362 radiographs), respectively. Further, forward positioning of the patient,

Table 1. The Frequency (Percentage) of Dentition Type of Participants Regarding the Gender

Dentition type		Female	Male	Total
Primary	No.	173	237	410
	%	10.5	14.5	25.0
Mixed	No.	204	206	410
	%	12.4	12.6	25.0
Permanent	No.	264	146	410
	%	16.1	8.9	25.0
Edentulous	No.	209	201	410
	%	12.7	12.3	25.0
Total	No.	850	790	1640
	%	51.8	48.2	100

Table 2. Mean Age of Participants According to Dentition Type

Dentition Type	Mean	Standard Deviation
Primary	5.0756	0.64972
Mixed	9.3927	1.52708
Permanent	32.8585	11.11045
Edentulous	62.4474	7.26513
Total	27.4222	23.76410

not detaching metal objects from the patient's body, and not placing the chin on the chin rest were the least positioning errors with 4.4% (73 radiographs), 1.1% (19 radiographs), and 0.7% (13 radiographs), respectively.

In the primary dentition, not attaching the tongue to the palate (50.4%) and the openness of the lips (31.2%) were the most prevalent errors in the radiographs. Likewise, in mixed dentition, not attaching the tongue to the palate (65.6%) and openness of the lips (44.6%) were the most frequent errors in the radiographs. In permanent dentition, not attaching the tongue to the palate (64.3%) and the higher positioning of the chin (25.1%) were the most radiographic errors, and not attaching the tongue to the palate (64.8%) and midline off (29.5%) were the most radiographic errors in the edentulous dentition.

To compare dentition types, a chi-square test was used, and the results of this test indicated that crouching, moving during radiography, forward positioning of the patient, and not placing the chin on the chin rest in the primary dentition period were more prevalent than in the other periods. Further, not attaching the tongue to the palate, openness of the lips, and not using the bite guide were more observed in the mixed dentition period compared

Table 3. Frequency (Percentage) of Positioning Errors According to Dentition Type

Type of Positioning Errors		Total	Primary	Mixed	Permanent	Edentulous	*P* Value
Not attaching the tongue to the palate	No.	1006	207	269	264	266	< 0.0001
	%	61.3	50.4	65.6	64.3	64.8	
Openness of lips	No.	464	128	183	96	57	< 0.0001
	%	28.2	31.2	44.6	23.4	13.9	
Higher positioning of chin	No.	362	68	98	103	93	0.016
	%	22	16.5	23.9	25.1	22.6	
Midline-off	No.	329	57	53	98	121	< 0.0001
	%	20	13.9	12.9	23.9	29.5	
Crouched patient	No.	211	67	59	51	34	0.005
	%	12.8	16.3	14.3	12.4	8.29	
Backward positioning of the patient	No.	182	18	8	91	65	< 0.0001
	%	11	4.3	1.95	22.1	15.8	
Moving during the radiography	No.	178	78	62	16	22	< 0.0001
	%	10.8	19.02	15.12	3.9	5.36	
Lower positioning of chin	No.	106	8	34	49	15	< 0.0001
	%	6.4	1.95	8.2	11.9	3.65	
Not using bite guide	No.	97	41	48	7	1	< 0.0001
	%	5.9	10	11.7	1.7	0.24	
Tilted neck	No.	84	19	19	20	26	0.636
	%	5.1	4.6	4.6	4.8	6.34	
Forward positioning of the patient	No.	73	45	15	6	7	< .0001
	%	4.4	10.9	3.6	1.4	1.7	
Not detached metal objects	No.	19	3	2	7	7	0.220
	%	1.1	0.73	0.48	1.7	1.7	
The chin is not on the chin rest	No.	13	8	4	0	1	0.007
	%	0.7	1.95	0.97	0	0.24	

to other periods. The backward positioning of the patient and the placement of the chin in a higher or lower position were more dominant in the permanent dentition period than in other periods. In edentulous patients, off-midline was reported to be higher than in other periods. Likewise, the frequency of positioning errors in each radiography was calculated, and the minimum and maximum errors observed in each radiography were zero and five errors, respectively. The presence of two errors (563 radiographs, 34.3%) had the highest frequency, and 123 radiographs (7.5%) were free of errors (Table 4). In Table 5, the frequency of acceptable or unacceptable radiographs is mentioned separately according to dentition type. Primary dentition with 95 radiographs (23.2%) had the highest unacceptable radiographs, and edentulous dentition with 29 radiographs (7.1%) had the lowest unacceptable radiographs. The chi-square test indicated that this finding was statistically significant ($P < 0.001$).

Discussion

Panoramic radiography has a wide application in common dental procedures because it covers almost all the anatomical areas required for the examination. Additionally, it provides the possibility of evaluating jaw fractures, dental evolution, and maxillary sinuses. Despite all these advantages, if the patient is not fixed in the proper position while imaging, all or part of the information will be lost. Therefore, panoramic radiography is susceptible to various types of errors (3). The result of the present study confirms this fact since only 7.5% of the 1640 radiographic images had no positioning error.

In Tabriz, in a study by Kaviani et al which evaluated panoramic images of 250 patients, 92.4% of the images had errors, 78% of which were errors caused by the patient's positioning (7). In Rasht, Mohtavipour et al evaluated 390 panoramic images taken by two trained technicians and reported that 306 images (78.5%) have positioning errors (8). In Nepal, Pandey et al (2) evaluated errors of 1010 panoramic images taken by radiology technicians or residents and reported a technical and situational error rate of 27.5%, most of which (16.2%) were related to positioning errors.

The most common positioning error in the present study was not attaching the tongue to the palate during the exposure. This result was consistent with the studies by Granlund et al (10), Pandey et al (2), and Newadkar et al (11). This error occurs when the patient does not put his tongue against the hard palate. The remaining air in the mouth is depicted as a radiolucent band on the root of the anterior maxillary teeth, which reduces the diagnostic quality of the radiographs. The reason for the high incidence of this error is probably that the technician could not explain to the patient that he/she should swallow the saliva while radiography and put the tongue to the palate. Some patients also have a misunderstanding and only stick the tip of the tongue to the palate, causing an error. In the present study, the openness of lips and higher positioning of the chin were the next most positioning errors.

In 2014, Salemi et al investigated the common errors in panoramic radiography, and among 220 cases, 75% had positioning errors. In their study, unlike the present study, the most common error was related to twisting the head to one side (31.8%). These researchers stated that not having appropriate interaction with patients and introducing the situation to them by students taking the images were the main causes of errors (3). Dhillon et al (6) analyzed the positioning errors in panoramic imaging and examined 1782 images. Among this number of images, 196 images (11%) were error-free. In this study, most errors were related to inappropriate tongue position toward the palate (55.7%), but the least frequent error was reported for the movement of the patient during imaging (1.6%), which is opposed to the results of the present study. In the present

Table 4. Frequency of Positioning Errors in Each Radiography According to the Dentition Type

Dentition Type	Positioning Errors in Each Radiography					
	0.00	1.00	2.00	3.00	4.00	5.00
Primary	36 (8.7%)	140 (34.1%)	123 (30%)	86 (20.9%)	22 (5.3%)	3 (1%)
Mixed	16 (3.9%)	102 (24.8%)	154 (37.5%)	110 (26.8%)	26 (6.3%)	2 (0.7%)
Permanent	32 (7.8%)	108 (26.3%)	149 (36.3%)	90 (21.9%)	23 (5.6%)	8 (2.1%)
Edentulous	39 (9.5%)	139 (33.9%)	137 (33.4%)	78 (19%)	17 (4.2%)	0
Total	123 (7.5%)	489 (29.8%)	563 (34.3%)	364 (22.1%)	88 (5.3%)	13 (1%)

Table 5. Frequency (Percentage) of Acceptable and Unacceptable Radiography According to the Dentition Type

		Primary	Mixed	Permanent	Edentulous	Total	*P* value
Acceptable	No.	315	351	380	381	1427	
	%	76.8%	85.6%	92.7%	92.9%	87.0%	
Unacceptable	No.	95	59	30	29	213	< 0.001
	%	23.2%	14.4%	7.3%	7.1%	13.0%	
Total	No.	410	410	410	410	410	
	%	100.0%	100.0%	100.0%	100.0%	100.0%	

study, forward positioning of the patient, not detaching the metal objects from the patient's body, and not placing the chin on the chin rest were the positioning errors with the lowest incidence.

When comparing the dentition types, crouched patients, movement during radiography, forward positioning of the patient, and not placing the chin on the chin rest in the primary dentition period were more present than in the other periods. The existence of such errors is not unexpected in children who are in the primary dentition period, are under 7 years old, and are not completely able to control their behavior. In the patients with edentulous, midline-off was more reported than in other periods. Since these patients do not have any teeth in their mouth, the diagnosis of the midline, the adjustment of the patient's head based on it, and the patient's ability to maintain the position will be challenging. Therefore, it is necessary to be more careful when preparing the radiography of these patients.

Not attaching the tongue to the palate, openness of lips, and not using the bite guide in the mixed dentition period were more observed than in the other periods. The backward positioning of the patient and higher or lower positioning of the chin were more common in the permanent dentition period than in the other periods. Peretz et al conducted a similar study entitled "Common errors in digital panoramic radiographs of patients with mixed dentition and patients with permanent dentition", and after examining 289 images, they concluded that there are fewer errors in individuals with mixed dentition (9). However, in the present study, the most acceptable radiographs were obtained from patients with edentulous, followed by permanent, and then mixed dentition, while the least acceptable radiographs were related to patients with primary dentition.

In the study by Peretz et al, the anterior position of the patient was the most common error in patients with mixed dentition, and the inappropriate position of the chin was the most common error in patients with the permanent dentition (9). However, in the present study, not attaching the tongue to the palate and openness of lips were the most common positioning errors in mixed dentition, and not attaching the tongue to the palate and higher positioning of the chin were the most common positioning errors in the permanent dentition.

The results of the present study and other similar studies clearly indicate that positioning error is abundantly observed in panoramic stereotypes. The focal plane of panoramic radiography has limited dimensions, so the slightest positioning error leads to distortion in radiographic images (12), decreases the quality of radiographic diagnosis, and ultimately leads to the repetition of radiography. The repetition of panoramic radiography results in an increased risk of cancer, which is estimated to be 0.21 to 1.9 per million (6,13). It seems that developing the skill of the operator, better communication of the operator with the patient, and spending more time adjusting the patient's position can reduce the number of errors, will help to provide high-quality radiographs, and ultimately reduces the unwanted exposure of the patient.

Of course, this study had some limitations. Patients who had previously experienced panoramic radiography were more likely able to adapt to radiographic conditions and eventually had fewer positioning errors compared to those who took panoramic radiography for the first time. This issue was not considered in this study. It is suggested that the effects of the number of performed panoramic radiographs be evaluated in future studies. Another limitation was the study conducted by the cross-sectional method that limits the possibility of generalizing the results to other communities. It is therefore recommended that comprehensive studies be conducted longitudinally.

Conclusions

Positioning error had a high prevalence in radiographic images, the most common of which was not attaching the tongue to the palate during radiography. Furthermore, in the primary dentition period, the number of acceptable radiographs was lower than in the other periods.

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Competing Interests

The authors declare that they have no conflict of interests.

Ethical Approval

Ethical considerations of this study were perused and approved by the Medical Ethics Committee of Tabriz University of Medical Sciences (Code: IR.TBZ.REC.1397.206).

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