

Improper Patient Positioning Incidence for Panoramic Radiographic Imaging of Pediatric Patients: Retrospective Study

SUMMARY

Background/Aim: Improper positioning of the patient reduces the diagnostic quality of panoramic radiographs. It is important to perfect the panoramic patient positioning technique to avoid unnecessary repeat exposures especially in pediatric patients. In this study, pediatric patient sample of records collected from an oral and dental health center were analyzed to determine the relative incidence of positioning errors of panoramic radiographs. **Material and Methods:** 3788 (1928 girls, 1860 boys) digital panoramic radiographs obtained from the stored data in the system were selected randomly. The radiographs were evaluated by two radiology specialists, by recording separately. The positioning errors of the images were categorized into ten groups: the chin tipped high, chin tipped low, a slumped position, the patient positioned forward, the patient positioned backward, failure to position the tongue against the palate, patient movement during exposure, the head tilted, and the head turned to one side. The results were statistically analyzed for positioning errors according to age and gender. **Results:** In 3788 radiographs, 2138 (56.4%) were error-free and 1650 (43.6%) were present with positioning errors. In the improper images, a single positional error was present in 1379 (83.6%); two positional errors were present in 248 (15%) and three or more positional errors in 23 (1.4%). The most common error observed was the tongue not being in contact with the hard palate (32.1%). On the other hand, the least common experienced error was patient movement during exposure (2.0%). **Conclusions:** The positioning errors of panoramic radiographs were common in the sample group of this study. Careful patient positioning can play a significant role in improving the radiographic quality and reducing the number of retakes.

Keywords: Panoramic Radiography, Pediatric Patients, Positioning Error

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Introduction

Panoramic radiography is a simple and valuable diagnostic tool often complementing clinical examination in diagnosing pathological conditions in children¹⁻³. Pediatric dentists also prefer to use a panoramic image because it covers a large region and is well tolerated by children⁴.

In pediatric patients, panoramic radiography can be used to monitor teeth before they emerge and analyze their location, shape, and angles as well as the presence of a supernumerary tooth or the absence of a tooth germ, thus preventing future problems⁵. Despite their merits however, radiographic exposures carry an inherent and well-documented quantifiable risk, which should not be underestimated, particularly in the younger age group

of patients³. Hence, it is more important to perfect the panoramic patient positioning, than to make unnecessary repeat exposures, especially in pediatric patients. The patient positioning is also critical in ensuring the diagnostic ability of the panoramic image. Inadequate diagnostic quality radiographs both lose diagnostic significance and cause unnecessary radiation to patients because they need to be repeated⁴. Numerous studies have analyzed the various errors and further assessed the reasons for retakes of panoramic radiographs of adult patients⁶⁻¹². However, the literature contains limited studies on comparisons of the positioning errors of panoramic radiographs among pediatric patients^{5,13,14}.

Understanding the cause of positioning errors and the importance of pediatric patient preparation can prevent most of the positioning errors in panoramic radiography. Therefore, this retrospective study is aimed to evaluate the frequency of positional errors in panoramic radiographs in a pediatric patient sample of records obtained from an oral and dental health center.

Material and Methods

In this retrospective study, the digital archive of an oral and dental health center was used. The interobserver agreement was found to be excellent by kappa statistics (0.81-1.00). Ethical approval was obtained from Bakirkoy Sadi Konuk Research and Training Hospital Ethical Committee. All images were taken with the same radiographic equipment (Ortophos XG, Sirona, Germany), operating at 73 kVp and 15 mA in accordance with the instructions of the manufacturer. The exposure time was 9 seconds with a magnification factor of 1.23. All radiographs were taken by 3 qualified radiographers with more than 8 years of experience. Digital panoramic radiographic images of pediatric patients from January 2017 to January 2018 were retrospectively analyzed by two qualified radiology specialists (NYO and KO). The radiographs were viewed under identical conditions without any modifications, on a 15-inch, 1280×800 resolution, 32-bit color mode computer monitor (Dell Inc, Round Rock, TX, USA).

A summary of positioning errors and their consequences for the panoramic images can be seen following¹⁵. Error 1: Absence of tongue and palate contact; radiolucency occurs on apices of the upper incisors due to palatoglossal air space or relative radiolucency appears on the coronal portion of both upper and lower incisors. Error 2: Open lips; the incisal area on the crowns may become obscured by the air space, Error 3: The patient is positioned too far forward; blurring and narrowing of anterior teeth, cervical spine superimposed on the ramus. Error 4: The patient is positioned too far backward; blurring and widening of anterior teeth,

the ghost image of rami superimposed on the posterior molars and rami, condyles close to the lateral edge of the image. Error 5: The chin is tipped too low; the curve of the occlusal plane goes up, roots of the lower incisors are cut-off, mandible widens vertically in the anterior region with the unclear trabecular pattern. Error 6: The chin is raised too high; occlusal plane curvature flattens or curves downwards, upper incisors blurred, hard palate shadow occurs wider and superimposes on roots of upper incisors, intercondylar distance increases. Error 7: The patient is slumped or incorrect positioning of the patient's spine; ghost image of the cervical spine superimposes on the anterior region. Error 8: The patient movement during exposure; blurring of the image, interior border of the mandible is wavy. Error 9: The patient's head is turned to the right; especially right teeth and ramus unequally magnified and severe overlap on contact points in the premolar area. Error 10: The patient's head is turned to the left; especially left teeth and ramus unequally magnified and severe overlap on contact points in premolar area.

The repeated images were not included in the study. In case multiple panoramic images were taken for a patient, only the first image was included in the study. The data was subjected to descriptive and statistical analysis using SPSS for Windows statistical software package version 18.0. T-test for continuous variables and Chi-Square-tests for qualitative variables were used to evaluate differences between groups. A p value, $p \leq 0.05$, was defined as statistically significant.

Results

3788 digital panoramic radiographic images of pediatric patients (1928 girls, 1860 boys) with a mean age of 9.34 ± 1.76 . Out of 3788 radiographs, 2138 radiographs (56.4%) were error-free and the remaining 1650 (43.6%) radiographs showed one or more positioning errors. Single position error rate is shown in Table 1. The radiographs with a single positional error were 1379 (36.4%); two positional errors were 248 (6.5%) and three or more positional errors were 23 (0.6%). The most typical error observed was the patient's tongue not being in contact with the hard palate seen in 530 radiographs (32.1%), followed by the patient positioning too far forward in 213 radiographs (16.3%). The least frequent error observed was the patient movement during exposure seen in 33 radiographs (2.0%). The most common two positional errors observed were the patient's tongue not being on the palate and the lips being open in 54 radiographs (1.4%). All of the panoramic images were divided into 4 subgroups according to the pediatric patient's age: 1: 7 and 8 years-old, Group 2: 9 and 10 years-old, Group 3: 11 and 12 years-old, Group 4: 13 and 14 years-old.

Table 1. Distribution of single positioning error with the frequencies among pediatric patients

No	Type of error	Number	Percent
1	The tongue is not on the plate	530	32.1
2	The lips are open.	213	12.9
3	The patient is positioned too far forward	269	16.3
4	The patient is positioned too far backward.	117	7.1
5	The chin is tipped too low.	134	8.1
6	The chin is raised too high	136	8.2
7	The patient is slumped.	239	14.5
8	The patient movement during exposure	33	2.0
9	The patient's head is turned to the right.	187	11.3
10	The patient's head is turned to the left.	84	5.1
Total		1379	100.0

The frequency of single errors and the statistically significant differences between age groups are shown in Table 2. Errors of patient being positioned too far back, slumped position and head malrotation were found to increase with age ($p \leq 0.05$). Table 3 shows the comparison of the frequency of errors between girls and boys. There are no significant differences with respect to the errors between boys and girls, except Error 1 and Error 9. The error of patient's tongue not being on palate was observed more common among girls, whereas the error of head malrotation to left was detected more common among boys (Table 3).

Table 2. Distribution of positional errors by age groups

Type of Error		Group 1 (%)	Group 2 (%)	Group 3 (%)	Group 4 (%)	P value
Error 1	Absent	73.7	65.6	58.8	75.0	0.000*
	Present	26.3	34.4	41.2	25.0	
Error 2	Absent	89.1	83.2	89.1	86.1	0.482
	Present	10.9	16.8	10.9	13.9	
Error 3	Absent	83.9	82.3	86.6	72.2	0.987
	Present	16.1	17.7	13.4	27.8	
Error 4	Absent	90.9	92.8	96.6	97.2	0.000*
	Present	9.1	7.2	3.4	2.8	
Error 5	Absent	90.5	93.9	91.6	91.7	0.352
	Present	9.5	6.1	8.4	8.3	
Error 6	Absent	91.2	92.2	91.9	94.4	0.500
	Present	8.8	7.8	8.1	5.6	
Error 7	Absent	82.3	88.9	86.8	86.1	0.018*
	Present	17.7	11.1	13.2	13.9	
Error 8	Absent	96.6	98.9	98.6	100	0.019*
	Present	3.1	1.1	1.4	0	
Error 9	Absent	88.0	90.0	88.2	86.1	0.892
	Present	12.0	10.0	11.8	13.9	
Error 10	Absent	93.0	96.5	96.1	97.2	0.010*
	Present	7.0	3.5	3.9	2.8	

%; percentage of group; p-values were calculated using the chi-squared test; Significant at $P \leq 0.05$.

Table 3. Distribution of positional errors by gender

Type of Error		Girl (%)	Boy (%)	P-value
Error 1	Absent	70.3	65.5	0.033*
	Present	29.7	34.5	
Error 2	Absent	87.2	87.0	0.915
	Present	12.8	13.0	
Error 3	Absent	81.9	85.4	0.054
	Present	18.1	14.6	
Error 4	Absent	93.0	92.8	0.837
	Present	7.0	7.2	
Error 5	Absent	91.0	92.8	0.177
	Present	9.0	7.2	
Error 6	Absent	92.7	90.9	0.179
	Present	7.3	9.1	
Error 7	Absent	86.9	84.1	0.104
	Present	13.1	15.9	
Error 8	Absent	98.4	97.6	0.235
	Present	1.6	2.4	
Error 9	Absent	86.7	90.9	0.012*
	Present	13.3	9.4	
Error 10	Absent	94.7	95.1	0.770
	Present	5.3	4.9	

%; percentage of group; p-values were calculated using the chi-squared test; Significant at $P \leq 0.05$.

Discussion

Numerous factors may lead to a reduction of diagnostic quality of panoramic radiographs. Among those factors are the patient positioning errors. Overall, while interpreting, it is valuable for the dentist to be aware of the common positional errors and to know how they affect the quality of the panoramic image. In this retrospective study, approximately half of these patients' images presented one or more positioning errors and, the most frequent samples were those with single error. On the other hand, the distribution of errors was not prevalent in contrast to the previous studies conducted among the pediatric samples^{5,13,14}.

Peretz *et al.*⁵ examined 289 digital radiographs of mixed and permanent dentitions and found only two radiographs in each group which contained no errors. In a study by Granlund *et al.*¹³, only 4 percent of 1287 panoramic radiographs of young orthodontic patients were subjectively evaluated to be without any positioning errors. The improved results in the current study by comparison with the previous studies are believed to be a consequence of having trained operators in the radiology section and low exposure time of panoramic radiographs.

The most common panoramic error encountered in the studies was the tongue not placed on the palate and on the radiograph, it appeared as radiolucent band on the

apex of the maxillary teeth. This finding is in agreement with the results obtained in the previous studies^{5,13,14}. The possible explanation for this error is that the patients may misunderstand the instructions, putting only the tip of the tongue on the palate, or the patients do not pay much attention to the instruction given by the technician. The frequency of this error was significantly higher in boys and this finding is not previously reported.

The second most common positioning error encountered was the patient being positioned too far forward with a prevalence of 16.3%. This error was also reported as a common error in the study of Peretz *et al.*⁵ at 24.5% for mixed dentition, 10.3% for the permanent dentition and 16.6% for child patients by Uzun *et al.*¹⁴. Authors have reported that the too far forward position of the patient was more prevalent among a younger group and this error might originate from the smaller size of the head in the younger age group¹⁷. In other studies, the incidence range of this error was found to be between 9.8 % and 34.7%^{6-8,12}. In this study, the backward positioning of the child patient was less prevalent than forwarding positioning. These errors might be attributed either to a misunderstanding of the patients or even to their underestimation of the importance of proper positioning.

The third most common error in this study was the head being rotated towards one side seen in 16.4% which caused asymmetrical condyle and ramus^{9,16-18}. In comparison with other studies, it was found that this error was in a similar range to one adult study (17.4%)⁶. Other studies^{5,13,14} reported either very low prevalence (0.7% for mixed dentition and 4.8% for permanent dentition)¹³ or higher prevalence (47%)⁵, (39.4%)¹⁴, respectively. This error might be due to improper head stabilizer or due to a lack of communication between the technician and the patient. The technician may spend more time in proper patient positioning to ensure that the patient's head is centered in three different planes which are midsagittal, occlusal, and the anteroposterior plane to uniformly record the maxillofacial complex¹⁸. The frequency of the error of the patient's head being turned to the left was higher in girls than boys.

The patient's slumped position seen in 14.5 % was another common error encountered. Available studies^{11,13,14} have reported a prevalence 2.1% for mixed dentition and 23.3% for permanent dentition¹¹ 10.5 %¹³ 7.4%¹⁴. The slumped position of the patient is an obvious error that can be readily noticed by an operator before exposure. There is a tendency to slump among patients when holding the hands of the machine. A ghost shadow on the symphysis may be attributed to patient slumping. The dental technician needs to be certain before taking the radiograph that the patient's back and spine are erect with the neck extended⁶.

The sixth common positioning error in this study was the patient's chin being tipped too high. If the patient's chin is too high, it causes a flat occlusal plane, splayed

condyles, and loss of sharpness of the maxillary incisors. In the current study, the prevalence of this error, at 8.1% was found to be lower in comparison to the study⁵ at 22.4% for mixed dentition, 19.2% for permanent dentition and comparison with the study¹³ at 17.5% for child patients.

The least common error was patient movement during exposure which caused blurring on the radiograph and also step defects on the inferior border of the mandible^{5,6,16,18,19}. Children and adolescents may not remain quiet and motionless during the panoramic procedures and movement errors could be more prevalent among our study group. However, patient movement during exposure in this study (2%) was significantly lower in comparison with another study¹⁴ at 20.2% among children patients. This error was also similarly reported in the study of Peretz *et al.*⁵ at 2.1% for mixed dentition, 1.4% for the permanent dentition and 4.5% for patients by Subhulakshmi *et al.*¹¹. The exposure time offered by the machine in our institute when used in child mode was nine seconds. This time is rather short for children in comparison with the other studies^{13,14} and it may be the reason for this low failure rate.

Conclusions

In this retrospective study, approximately half of the patients' images presented with one or more positioning errors and the most frequent samples were those with only one error. The most common positioning error was found to be the tongue not being placed against the palate and it was decided that improved communication with the pediatric patient is necessary to ensure compliance with this instruction. In order not to miss the pathologies that are revealed in panoramic radiographs, and to prevent misdiagnoses, it is necessary to know the causes of the errors and to provide suitable training to technicians. It can be deduced that operator skill, better communication with the child patient, and spending time in patient positioning could decrease the number of errors and help produce higher quality radiographs, thereby reducing unwanted patient exposure.

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