



Determination of different positioning errors in digital panoramic radiography: A retrospective study

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Abstract

Aim: This study aims to determine the different positioning errors in digital panoramic radiographs in a sample of records collected from the department of oral medicine and radiology.

Materials and Methods: The study consisted of 500 panoramic radiographs obtained from the Department of Oral Medicine and Radiology, AME's Dental College and Hospital, Raichur, was taken serially (from the year January 2019), and was retrospectively assessed for positioning errors. These positioning errors were assessed by two oral and maxillofacial radiology specialists using a pro forma enlisting the errors. They also evaluated the relative frequency of all different positioning errors.

Statistical Analysis: Data were obtained and the kappa value for intraobserver agreement was calculated, which suggested that among the observers, the kappa value represents intermediate to good agreement.

Results: Out of 500 panoramic radiographs evaluated by two observers, 86 (17.2%) had no errors, while 414 (82.8%) showed one or more positioning errors. The most common error in our study was found to be head turned to one side (30.8%) and the least common error was patient movement (1.0%).

Conclusion: Positioning errors are very common in panoramic radiography. Patient positioning is the most important factor to avoid errors in preventing repetitive exposure to the patient. We all dental professionals must understand the consequence of these errors on diagnostic yield of good radiographs.

Introduction

Panoramic radiography is a unique, simple, and a very useful extraoral film technique that allows the dentist to visualize the entire maxillomandibular dentition and related structures, from condyle to condyle, on one film.^[1] Moreover, panoramic radiograph is one of the routinely used investigations in dentistry. The significance of panoramic radiograph is reduced when they are of poor diagnostic quality.^[1]

To obtain diagnostically useful panoramic radiographs, it is necessary to prepare patients properly and position their heads carefully in the image layer. Image layer is nothing but a three-dimensional curved zone or "focal trough" where the structures lying within this layer are reasonably well defined on the final panoramic image.^[2] Ability to identify various errors plays a significant role in correct interpretation of the panoramic radiographs.

Hence, our aim is to determine the different positioning errors in digital panoramic radiographs in a sample of records collected from the department of oral medicine and radiology.

Materials and Methods

The study was conducted in the Department of Oral Medicine and Radiology, AME's Dental College and Hospital, Raichur, Karnataka, India. Five hundred panoramic radiographs taken serially (from the year January 2019) were retrospectively assessed for positioning errors. These positioning errors were assessed by two oral and maxillofacial radiology specialists using a pro forma enlisting the errors.

Digital panoramic radiographs were taken for all the study subjects using PLANMECA 2006, 75 kVp, and 10 mA according to manufacturer's instructions. The exposure parameters were

as follows: The total exposure time was 13.89 s, magnification factor 1.27 (+10%), default KvP factor 75 mv, and current 10 mA. The radiographs were taken by the postgraduate students of our department and a radiology technician with more than 10 years of experience. The films were digitally processed after the completion of exposure cycle using DRYSTAR 5032 digital printer.

All the 500 panoramic radiographs were assessed by two observers, assistant professors of oral and maxillofacial radiology specialists, and no particular sequence was followed, but the observations recorded by one observer were not disclosed to the other observer. The panoramic radiographs were assessed for the following positioning errors: Anterior teeth positioning, cervical spine position, occlusion plane up (chin tipped up), occlusion plane down (chin tipped down), tongue position, patient movement during exposure, head tilt, head turn to one side, and other artifacts (ghost image). These were the most common positioning errors according to Langland and Langlais enlisted in Table 1.^[3]

Statistical analysis

Data analysis was performed using SPSS software, version 20 packages, and intraobserver agreement was calculated using kappa analysis. The kappa value for intraobserver agreement was calculated. Kappa >0.75 represents excellent agreement, kappa 0.40 represents poor agreement, and kappa 0.40–0.75 represents intermediate to good agreement between observer. Despite the variability, the overall kappa value for intraobserver reliability was 0.552, which represents intermediate to good results.

Results

Out of 500 panoramic radiographs evaluated by two observers, 86 (17.2%) had no errors, while 414 (82.8%) showed one or more positioning errors. The most common error in our study was found to be head turned to one side (30.8%) [Figure 1] and the least common error was patient movement (1.0%).

The other common errors in our study were anterior teeth positioning (24.3%), head tilt (20.1%) [Figure 2], overlapping of spine in lower anterior region due to slumping (15.6%) [Figure 3], and other artifacts such as ghost image (26.9%), error of tongue positioning (4.9%) [Figure 4] in radiographs, and occlusal plane up (chin up) (16.1%) [Figure 5] and chin down (6.3%) [Figure 6]. The relative frequency of different positioning errors has been observed by two observers, as shown in Table 2 and is represented by a bar graph.

Discussion

Panoramic radiographs were evaluated in the study obtained from the Department of Oral Medicine and Radiology, AME's Dental College and Hospital, Raichur, were taken serially (from the year January 2019), and were retrospectively assessed for positioning errors. The radiographs of all the patients, who were taking radiographs for their own diagnostic purpose, were taken in the serial order, and the department oral and maxillofacial radiology specialists were unaware of the study.

The present study revealed that out of 500 panoramic radiographs, 82.8% of radiographs examined had one or more positioning errors in them, thus reducing the diagnostic yield of these radiographic images. Our results were in correlation

Table 1: Positioning errors and their presentation on panoramic radiographs

Positioning error	Presentation on panoramic radiographs
Chin tipped high	Flat occlusal plane, mandible is broad and flat, maxillary incisors blurry, hard palate superimposed on roots, condyles at edge of film
Chin tipped low	Mandible shaped like a "v," too much smile line, condyles at top of film, spine forms arch
Cervical position – slumped	Pyramid-shaped opacity centered in the middle of image
Patient position forward	Anterior teeth blurry, too small and narrow, spine visible on sides of film
Position positioned backward	Anterior teeth blurry and wide, ghosting of mandible and spine, condyles close to edge of film
Failure to position the tongue against the palate	Large radiolucent shadow superimposed over apices of maxillary teeth between palate and dorsum of tongue
Patient movement during exposure	Portions of radiographs are blurred, large step defects in inferior border of mandible
Head is tilted one side	Condyles are not equal appear higher the other, nasal structures distorted
Head is turned to one side	Asymmetry of condyles , ramus is wider on one side than the other, uneven pattern of blurring throughout arch, nasal structures not clear



Figure 1: Head turned to one side, causing an asymmetry of condyles, and wider teeth and ramus on one side the other



Figure 2: Head tilted to one side/ causing one condyle to appear higher than the other



Figure 3: Slumped cervical spine, appearing as a pyramid shaped opacity, centered at the lower half of the film

with Rushton *et al.* who sampled the quality of 1813 panoramic radiographs. The patient positioning errors appeared in over 85% of the radiographs^[4] and Schiff *et al.* who reported that 80% of the panoramic radiographs had positioning errors.^[5]

In the present study, the most common error was found to be head turn to one side (30.8%) which was in correlation with Khator *et al.* who showed (33.8%) error.^[6] The probable reason for head turned to one side being the most common error could be improper head stabilizer or lack of communication between the radiology technician and the patient. The



Figure 4: Panoramic radiograph shows patient failure to position the tongue against palate, a radiolucent shadow will be superimposed over the apices of maxillary teeth



Figure 5: Patients chin tipped up/flat occlusal plane, causing loss of sharpness of maxillary incisors



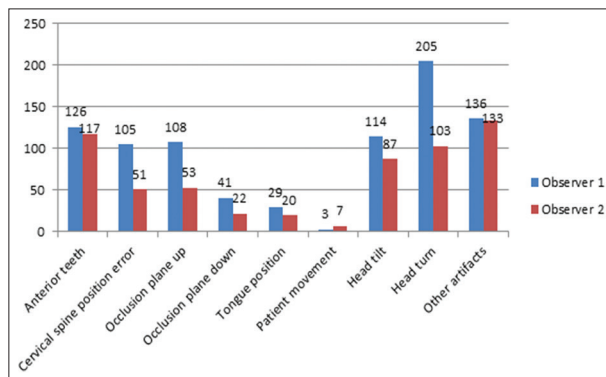
Figure 6: Chin tipped down/low, mandible shaped like “v,” too much smile line, the apices of mandibular incisors are fuzzy

radiology technician should explain properly to the patient about positioning and ensure that the patient’s head must be centered in three different planes which are mid-sagittal (perpendicular to the floor), occlusal (parallel to the floor), and the anteroposterior plane to uniformly record the maxillofacial complex.^[6]

In our study, the least common error in our study, i.e., patient movement during exposure (1.0%), is in accordance with the results of the study performed by Dhillon *et al.* (1.6%)^[7] and Rushton *et al.* (0.8%).^[4]

Table 2: Relative frequency of different positioning errors as observed by the two observers

Errors	Observer 1 (%)	Observer 2 (%)	Kappa value
Anterior teeth positioning	25.2	23.4	0.549
Cervical spine –slumped position	21	10.2	0.450
Chin up/occlusal plane up	21.6	10.6	0.448
Chin down/occlusal plane down	8.2	4.4	0.448
Tongue position	5.8	4	0.464
Patient movement during exposure	0.6	1.4	0.597
Head tilt	22.8	17.4	0.548
Head turn	41	20.6	0.383
Other artifacts (ghost images)	27.2	26.6	0.893

**Graph 1:** Bar graph showing frequency of positioning errors as observed by two observers

The second most common error was the presence of ghost images and artifacts (26.9%) in our study which is in accordance to Akarslan *et al.*^[8]

In dental panoramic tomography, minor positioning errors can cause image distortion as its focal plane has limited dimensions. The quality of each radiograph is of supreme importance as radiographic results may be impaired if any error is introduced during patient preparation and positioning or processing of radiograph. Errors in radiographic image may result in reduced diagnostic benefits that may require repeating radiograph resulting in patient exposure to unnecessary ionizing radiations.^[9]

Conclusion

Positioning errors are very common in panoramic radiography. Patient positioning is the most important factor to avoid errors in preventing repetitive exposure to the patient. We all dental professionals must understand the consequence of these errors on diagnostic yield of good radiographs. Understanding the cause of positioning errors and the importance of patient

preparation and proper positioning can prevent most of the positioning errors in panoramic radiography and thereby can minimize unnecessary X-ray exposure.

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