Technical Error Factors on Panoramic Radiographic Examination at the Radiology Installation of Unjani Dental and Mouth Hospital

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Abstract

Panoramic is a three-dimensional curved zone where anatomical structures are well defined on panoramic radiography. Panoramic radiography includes a detailed anatomy of the jaw complex with some superimpositions and distortions that can be exacerbated by technical errors in image acquisition as well as many extra-jaw anatomical structures that are able to give clear description to interpretate. Therefore, in obtaining a panoramic radiograph it is necessary to obtain the desired structure with high quality and minimal distortion. Errors that often occur in producing good panoramic radiographs are technical errors or when positioning the patient and during the panoramic examination. The purpose of this study was to determine the main factors causing the errors so that technician can produce good quality radiographs, take into account patient placement at the time of examination, perform film processing, and handle general film procedures. The research method used a quantitative method with a descriptive observational approach. The number of samples was 64 radiographs, which are adult patients over 18 years old with the use of exposure factors in the range of 60kV, 10mA and 16.4s. All radiographs were taken by qualified radiographers with more than 5 years of experience. The radiographs were viewed and observed without any modification on a computed radiography monitor screen. Radiographic results will be evaluated by experienced technician who have worked more than 5 years. Evaluation is obtained by analyzing the data descriptively in the form of assessment of the percentage of rejection of panoramic radiographs to make conclusions. Out of the 2418 panoramic radiographs viewed, 2354 (97%) radiographs had no errors while 64 (3%) radiographs showed one or more positioning error. The most common positioning error observed in the radiographs was failure to position chin tipped high (56.02%). Whereas the least common error recorded were movement and apron shadow (1.15%).

Keywords: Radiography, Panoramic, Film quality

1. Introduction

The use of X-ray radiation in panoramic examinations has very short wave properties and has high transferable energy through the interaction of atoms. The nature of X-rays is able to penetrate solid objects although with different levels. With the interaction of the ionization process, there will be radiation effects on the body, both stochastic and non-stochastic (Haring & Jansen, 2000).

In the process of panoramic imaging, the x-ray tube and film move simultaneously around the patient during the exposure. During exposure the movement of the x-ray tube and film moves in opposite directions which is called Tomography (Haring & Jansen, 2000). Panoramic radiography aims to view images of facial structures which include the maxillary and mandibular arches and their supporting structures such as the maxillary antrum, nasal fossa, temporomandibular joint, styloid process, and hyoid bone in one film (White & Pharoah, 2014). This examination can yield diagnostic information that is difficult to obtain on intra-oral examination such as evaluation of trauma, impacted third molars, extensive dental, bone disease, extensive lesions, out-of-place tooth growth, retained teeth or edentulous patients.), temporomandibular joint (TMJ) and abnormal growth (White & Pharoah, 2014).

Panoramic images include complex jaw anatomy with multiple superimpositions and distortions which can be exacerbated by technical errors in acquiring the image as well as depicting many anatomical structures outside the jaws which may lead to additional interpretations. The interpretation of panoramic radiography begins with an understanding of the normal anatomy of the head and neck (Perschbacher, 2012).

The use of digital imaging in panoramic examinations can minimize tool processing errors. Therefore, proper patient positioning and preparation is essential to produce sharp, accurate, and undistorted images that are not affected by shadow ghost. Panoramic radiographic artifacts may contain radiopaque spots and radiolucentcies which are reflections of various structures in the area examined as well as soft tissue shadows and anatomical air spaces making...

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patient positioning all the more important. Inaccuracies in patient positioning lead to discrepancies between horizontal and vertical magnification, with consequent image distortion (Dhillon et al., 2012). This is in accordance with the results of a study conducted by Dhillon, et al in India in 2012 found on panoramic radiograph results, 55.7% was a failure of the tongue position against the palate and also in a study conducted by Bagherpour in Iran in 2012 2018, 94.8% found that the tongue was not on the palate.

Based on preliminary observations at UNJANI Oral and Dental Hospital, the researchers found that the panoramic radiographs were rejected due to an incorrect head position that was not straight and the position of the tongue not attached to the palate which caused the results of the film to contain artifacts, the position of the head that was too down or too up.

2. Literature Review

2.1. Panoramic Radiography

Advances in radiology technology have developed from conventional systems to digital imaging systems. The use of digital radiography in the scope of radiology services makes radiograph results more detailed but still has to pay attention to radiographic quality including contrast, density, sharpness and distortion

Panoramic radiography or Orthopanthomography is a photo technique used to produce a tomographic image showing facial structures that include the maxillary arch and the Mandible and its supporting structures with minimal distortion and overlap, of detailed anatomy on the contralateral side (Ruth et al., 2021). Panoramic images include complex jaw anatomy with multiple superimpositions and distortions which can be exacerbated by technical errors in acquiring a image as well as depicting many of the anatomical structures outside

![Figure 1: Anatomical panoramic radiograph (Ruth et al, 2021)](image-url)
the jaws which may give rise to additional interpretations. The interpretation of panoramic radiography begins with an understanding of the normal anatomy of the head and neck (Perschbacher, 2012).

Other structures of the head and neck that are present in the image, in the form of overlapping hard and soft tissues and airways, create superimposed shadows that can cause errors in interpretation.

### 2.2. Working Principle of Panoramic Radiography

In panoramic imaging, the x-ray tube and film are connected and rotate simultaneously around the patient during the exposure. The point of the axis around which the receptor and the head of the x-ray tube rotate is called the center of rotation. Modern panoramic x-ray units use a continuous motion of a center of rotation rather than some fixed center location (Figure 2).

![Figure 2](image)

**Figure 2:** The working principle of the panoramic, tube and receptor rotate simultaneously around the patient (Lannucci et al., 2013)

This change in rotation allows the image layer to adjust to the elliptical shape of the dental arch. The x-ray tube and movable receptor produce an area known as the focal through which is used to determine where the dental arch should be positioned to obtain the sharpest image (Figure 3). Structures that are located inside the focal through appear quite clear on panoramic images, while structures that are outside the focal through appear blurry or unclear and are not easily visible on panoramic images (Lannucci et al., 2013).

![Figure 3](image)

**Figure 3:** The center of rotation of the X-ray axis which moves continuously as the tube head and receptors rotate around the patient (Lannucci et al., 2013)

In this radiographic technique, the position of the patient is very important to ensure quality final images and focus on the teeth and bone structure surrounding alveoli. Therefore, successful panoramic radiography requires careful patient positioning and proper technique. Proper technical procedures require the patient to be in an upright position with the neck extended, shoulders down, back straight and feet together. In addition, a Frankfort plane
parallel to the ground and a median sagittal plane perpendicular to the ground should be established with a chin brace on the anterior lobe of the chin with the tongue resting on the roof of the mouth (Figure 4) (Rondon et al., 2014).

![Figure 4: Patient position on panoramic radiography device](image)

Panoramic radiographs are widely used for screening patients prior to dental prosthesis treatment, to ensure the presence or absence of roots, cysts, foreign bodies, and neoplasms. Measurement of the horizontal direction on panoramic radiographs can be used for tumor treatment plans, evaluation of bone conditions after tumor treatment and jaw fractures, as well as evaluation of TMJ and mandible conditions associated with suspected jaw development anomalies (hyperplasia or mandibular hypoplasia). Panoramic radiographs can be used for extensive radiographic examinations in the maxillomandibular area (Shahidi et al., 2018).

2.3. Panoramic Errors

According to White & Pharoah (2014) panoramic films rejected is as follows:

A. Errors in patient preparation
   Errors in patient preparation, including:
   a. Not removing jewelry, such as earrings, necklaces and piercings;
   b. Not removing dentures;
   c. Not removing orthodontic appliances;
   d. Do not take off the glasses;
   e. Improper use of apron.

B. Incorrect patient positioning
   Incorrect patient positioning, including:
   a. The position of the spine is not straight;
   b. Incisors not biting the bite block properly (front fault);
   c. Not using a light beam marker that is used to ensure the vertical midsagittal plane and the head is not rotated (horizontal error);
   d. Do not use a light beam marker that is used to ensure a horizontal Frankfort plane (vertical error);
   e. Failure to instruct the patient to place the tongue against the roof of the mouth (air shadow error);
   f. Failure of patient to instruct to remain still during exposure.

C. Equipment position errors
   Equipment position errors include:
   a. Failure to adjust the height position adjustment correctly;
   b. Failure to set exposure factor;
   c. Failure to place tape properly.

Examples of common patient preparation and positioning errors:
Based on the observation results, the repetition of panoramic photos in the digital imaging process, errors due to film processing can be eliminated but the most errors are caused by operator errors during patient positioning and patient preparation.

3. Material and Methods

Based on the problems studied, the method used in this research is descriptive observation method with a quantitative approach.

This study was carried on 64 panoramic radiograph that were taken from January to October 2022 in the Unjani Dental and Mouth Hospital. Panoramic examination entirely uses a panoramic Digital technician aircraft brand Soredex Minray Finland, with the use of 66kV kV, 10mA and 16.4s. This examination is carried out by technician who have worked for more than 5 years. The radiograph results are then analyzed.

The assessment of the frequency of errors consisted of the position of the patient's chin tipped high, the head was too close to the IR, Head position is too backward patient, Low Density, Image Artifact, Image Apron Shadow and movement (Figure 11-17). The results of the radiograph can be viewed on a computer screen and then an assessment is made of whether the radiograph results are acceptable or not.
**Figure 11**: The patient's chin tipped high the space curve is flat.

**Figure 12**: Too close to the IR, the spine is in front near the mandibular ramus.

**Figure 13**: Head position is too backward, ghost image of the spine on the anterior teeth.

**Figure 14**: Low Density

**Figure 15**: Image Artifact

**Figure 16**: Image Apron Shadow

**Figure 17**: Image Movement

<table>
<thead>
<tr>
<th>Position error</th>
<th>Manifestation of radiograph results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin too high</td>
<td>Maxillary incisors opaque, hard palate resting on root, occlusal plane flat, mandible broad and flat, condyle at film margin</td>
</tr>
<tr>
<td>Patient's head too close to IR</td>
<td>Front teeth blurry, too small and narrow, spine visible on film side</td>
</tr>
<tr>
<td>Position of head too far from IR</td>
<td>Front teeth blurry and wide, ghosting of mandible and spine, condyles close to edge of film</td>
</tr>
<tr>
<td>Apron shadow artifact</td>
<td>Radiopaque shadow over the anterior part of the mandible</td>
</tr>
<tr>
<td>Low density</td>
<td>Radiograph with high kontras</td>
</tr>
<tr>
<td>Movement</td>
<td>Portion of radiograph are blurred</td>
</tr>
</tbody>
</table>
4. Results and Discussion

4.1. Results

Out of the 2418 panoramic radiographs viewed, 2354 (97%) radiographs had no errors while 64 (3%) radiographs showed one or more positioning error. The most common positioning error observed in the radiographs was failure to position chin tipped high (56.02%). Whereas the least common error recorded were movement and apron shadow (1.15%) can seen in the Table 2.

<table>
<thead>
<tr>
<th>Positioning errors</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin tipped high</td>
<td>47</td>
<td>54.02</td>
</tr>
<tr>
<td>Patient positioned forward</td>
<td>17</td>
<td>19.54</td>
</tr>
<tr>
<td>Patient positioned backward</td>
<td>12</td>
<td>13.79</td>
</tr>
<tr>
<td>Low density</td>
<td>7</td>
<td>8.05</td>
</tr>
<tr>
<td>Movement</td>
<td>1</td>
<td>1.15</td>
</tr>
<tr>
<td>Artifact</td>
<td>2</td>
<td>2.30</td>
</tr>
<tr>
<td>Apron shadow</td>
<td>1</td>
<td>1.15</td>
</tr>
</tbody>
</table>

The radiographs free of positioning errors and therefore classifiable as ‘excellent’ using the recommended criteria were 2359 (97%). 56 (87.5%) were ‘diagnostically acceptable’, containing errors which did not detract from the diagnostic utility of the radiograph. The remaining 8 (12.5%) were ‘unacceptable’ can see Table 3.

<table>
<thead>
<tr>
<th>Quality</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>2354</td>
<td>97.35</td>
</tr>
<tr>
<td>Diagnostically acceptable</td>
<td>56</td>
<td>2.32</td>
</tr>
<tr>
<td>Diagnostically unacceptable</td>
<td>8</td>
<td>0.33</td>
</tr>
</tbody>
</table>

4.2 Discussion

The radiograph panoramic evaluated in the present study were gathered from inactive patient files from the Department of Unjani Dental and Mouth Hospital, Bandung for the purpose of assessing positioning errors and quality in panoramic radiography. In this study, processing and handling errors were not considered since the radiographs were taken from a digital panoramic. The high frequency of positioning errors was striking. Another explanation was that the patients sometimes might misunderstand the instructions or the patients did not pay much attention to the instruction given by the technician, instructs the head to be in an upright position but the head is tilted back. In this study, this error was found in Chin tipped high (54.02%) of the radiographs. While in studies by Dhillon et al. (2012) The most common error observed was the failure to position the tongue against the palate (55.7%). In a study by Glass et al. the highest error reported the same with our studies was a high chin position (Bagherpout et al., 2018).

5. Conclusion

In conclusion, positioning errors are common in panoramic radiographies. Based on our findings, the most common positioning error was chin is placed too high. The need for training for technician, better communication with the patient, and spending time in patient positioning could decrease the number of errors and help produce high quality radiographs. Carrying out this film rejection analysis.

Acknowledgments

We would like to thank the technician in the department of Unjani Dental and Mouth Hospital, Bandung, Indonesia
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