

Common Errors in Panoramic Radiographs: A review

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Abstract

Panoramic radiography (also called pantomography) is an imaging technique that produce a wide, curved image layer, the dentist can see the patient's whole set of dentition and surrounding tissues on a single film, , the x-ray source and image receptor will have rotated around the patient's head to accomplish this. This review, an attempt is made to summarize the common errors associated with patient preparation, patient positioning, patient motion, exposure, handling, and film processing, in addition to digital panoramic imaging software tools, brightness, and contrast adjustment to give an evidence to reduce the chance of errors occurrences in future, so this assist the dental radiologist improving their practice and experience.

Keywords: Review; panoramic radiography; errors.

Introduction

Panoramic radiography is one of the most imaging modalities utilized among dental clinics because all maxillary and mandibular teeth and their related structures are viewed on a single film in addition to other important structures nearby such as the maxillary sinuses, the temporomandibular joint (TMJ), and the hyoid bone. The technique is reasonably easy and the dose of radiation is considered low, especially with modern equipment (Whaites, 2003; Langland, 2002). This radiographic technique is a two-dimensional image that provide a three-dimensional focal trough for the curved jaws. Any structures inside the focal trough, will be sharply focused on the resultant radiograph (Whaites, 2003; Costa, 2021; Ramos, 2016). The dental panoramic radiography applied in almost circumstances of general dental practice: As part of an orthodontic assessment

to know the dentition status and the presence/absence of teeth, as alternative to intraoral films in assess too large bony lesions, pre-surgery, periodontal assessment, third molars assessment, to diagnose mandibular fractures in all but not the anterior area, also it is useful in antral disease and the TMJ disease. (Whaites, 2003) However, the panoramic radiographs have many advantages, but the diagnostic value of these films is considerably depend on the awareness of the clinicians to the errors that caused by incorrect patient-positioning which is crucial for capturing for a clear, precise, and undistorted image or the technical errors (Rushton, 1999; Murray, 2002).

Panoramic image formation

During panoramic radiography, the source of radiation rotates around the patient's head in one direction and the image

receptor rotate in another direction, while the patient remains fixed in his position (Iannucci, 2017). This rotation forming an image at the midsagittal plane to either side of the patient's head. The anatomical landmarks sharpness represents the focal trough area; however other areas are blurring. (Stabulas-Savage, 2019; American Dental Association Council on Scientific Affairs, 2020). The resulting of this procedure is a radiograph that showing the nasal cavity and central incisors in the center of the image, laterally the cervical spine appears (Scarfe, 2020). Although the panoramic radiograph is a complex image, the radiologist should be well informed about focal trough, real images, double and ghost images to create a detailed and diagnostic panoramic image (Iannucci, 2017; Stabulas-Savage, 2019; Pawar, 2014).

Panoramic imaging technique

Panoramic radiographic technique requires good preparation of the device and the patient, as well as correct positioning of the patient in the machine. To prevent any errors. (Thomson, 2012; Boeddinghaus, 2006; Withers, 2020) before the film exposure, the OPG machine should be prepared with the proper infection control barriers and adjust accordingly the exposure parameters depending on the patient's size, age, and length. (Subbulakshmi, 2016) The practitioner should cleared the radiographic process and give the patients all the require instructions. (Iannucci, 2017; Scarfe, 2020). After the exposure, the clinician should assessed the panoramic radiograph for image quality criteria (Scarfe, 2020).

Panoramic imaging errors

Patient errors

Patient positioning errors

Too far forward position

The anterior teeth appear narrowed with pseudospaces. The crowns of the teeth may misdiagnose as fractured due to the cut out of the image layer, while the cervical spine appears superimposed on left and right sides on the ramus and condyles (Whaites, 2003; Iannucci, 2017), (Figure, 1a) represent a panoramic radiograph showing very narrow anterior teeth when the patient positioned in too far forward position.

Too far backward position

The anterior teeth appear expanded with the lower turbinate and meatus are spread on the maxillary sinus, while the condylar bones showed on lateral edges. There will be ghost images of the ramus and all the image structures appear too large. (Iannucci, 2017).

Patient's head errors

Turned or twisted head

Both posterior teeth and the ramus on one side appear widened and there will be overlapping interproximally, while on the other side the posterior teeth and the ramus appear narrowed. and intersected by a ghost image of the contralateral ramus (Whaites, 2003; Iannucci, 2017; Anil, 2016), (Figure, 1b) represent twisted patient's head, a Real image of cervical spine is visible and the ghost of spine (white arrow) is seen as a blurry radiopaque image in the midline.

Tilted head

If the patient's head is slightly tilted in the machine, there will be a widening at the posterior teeth at one side with expanding gap between both jaws. The lower border of the mandibular bone usually

appears to be in the upward direction above the horizontal plane. with the broad interocclusal gap, Also there will be enlargement of the condyle and is above the contralateral condyle, that is lower and smaller (Peretz, 2012).

The chin errors

Too low tipped chin

When the tipping of chin is too much low the line of smile that formed by the occlusal space is overstated. The most obvious artifact is the cut-off of the lower anterior teeth apices in addition to the widening of the mandibular bone in vertical direction, with bad view of the trabecular pattern, while the hyoid bone imaged as double or ghost image. The both condyles can be seen at the upper border of the image or may be show a cutted off view by its upper region. (Anil, 2016), (Figure, 2a) showing panoramic radiograph error associated downward tipping of the patients chin.

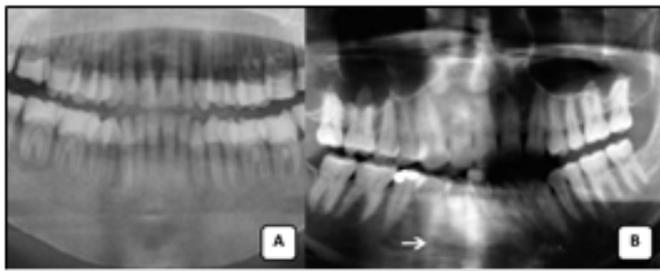


Figure (1): Panoramic radiograph showing (a) narrowed anterior teeth in too far forward position. adopted from: (Iannucci, 2017), (b) twisted patient's head. adopted from (Anil, 2016).

Too high raised chin

When raising the chin too much high the smile line will be lost completely and there will be flattened occlusal plane, in some cases reverse curve occlusal line appears as sad configuration. The palate

represented as radiopaque wide line that is directed downward or superimpose on the upper teeth apices. The condyles approach bilaterally (Whaites, 2003; Anil, 2016) (Figure, 2b) represent the raising up chin.

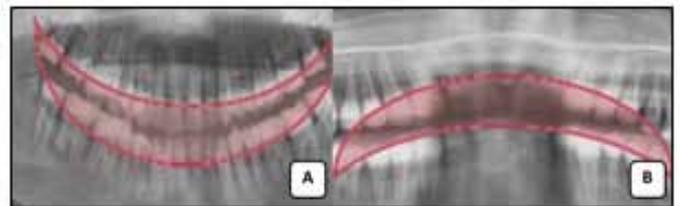


Figure (2): panoramic radiograph showing chin errors: (a) Chin tipped down (b) chin raised up. adopted from; Iannucci and Howerton (Iannucci, 2017).

Chin rest

When the chin is positioned in the wroge way on the chin rest, the area of the nosesinuses will be cut off from the superior edge of the image (Peretz, 2012)

The patient's neck error

When the patient is set down, the neck of the patient will have stretched forward forming a ghost type of radiographic image at the middle of the image and the anterior teeth cannot have seen obviously due to the radiopacity of the spine that superimposed at that region (White and Pharoah 2019; Park, 2014).

The tongue error

When the tongue position not at the plate and the lips were not in contact, there will be air space between upper and lower lip so the coronal part of the maxillary and mandibular teeth are foggy. Upper teeth apices will be not clear because of palatoglossal air spaces which represent

as dark air space located at the junction between the hard and soft palates with the dorsum of the tongue. (Whaites, 2003; Cordesmeyer, 2016; Loughlin, 2017) (Figure 3), panoramic radiograph represent the tongue is not on the palate with a dark, radiolucent area palatoglossal airspace just under the hard palate.



Figure (3): panoramic radiograph showing the tongue is not on the palate. adopted from (Anil, 2016).

Technical errors

(1) When the operator doesn't ask the patients to take off any prostheses or jewelry, there will be a radiopaque projection on the radiographic image, they are mostly cause formation of ghost image and obscuring relevant details (Anil, 2016).

(2) movement of the patient: When the patients move during the exposure time, the lower border of the mandibular cortex will appear as discontinue near the posterior teeth (Park, 2014). (3) A protective lead apron: The protective thyroid shield and lead apron should be discouraging to use due to the interference with the resultant radiograph resulting in radiopaque projections area (Costa, 2021; Iannucci, 2017; Anil, 2016).

(4) Bite guide: If the operator doesn't instruct the patient about how to use bite guide, the anterior incisal and posterior occlusal surfaces of the maxillary and mandibular teeth will show an overlapping image (Ekstromer, 2014).

Radiographic film errors

These errors exist only in conventional panoramic radiographs.

Static electricity

This error occurs during inserting and removing the radiographic film to the cassette in conventional panoramic radiography and not examined in digital radiography which doesn't require radiographic film (Iannucci, 2017).

Parameter of exposure setting

The recommended exposure setting parameters typically adjusted between 70-100 kilovoltage and 4-12 miliamper most of exposure issues can be directly solved through altering image brightness, sharpness, and contrast (Iannucci, 2017; Granlund, 2012; Dhillon et al, 2012).

Darkroom and processing

Too darkened or too lighted images lose its clarity owing to underexposure, wrong setting parameters or inappropriate processing (Figure 4), whereas too darkened images listed as the outcome of overexposure or wrong parameters or poor processing procedures. Foggy film produced when using outdated film or chemicals, damage due to improper packaging and film storage. When a film is double-exposed, two separate pictures are captured on that individual film (Nileema, 2016; Langland, 2002; Kaviani, 2008)

Foreign materials

A radiopaque line or spot on the film may be caused by foreign material such as hair,

paper, or debris lodged between the film and the screen, preventing the complete exposure of film in that location and potentially leading to incorrect diagnosis (Anil, 2016).

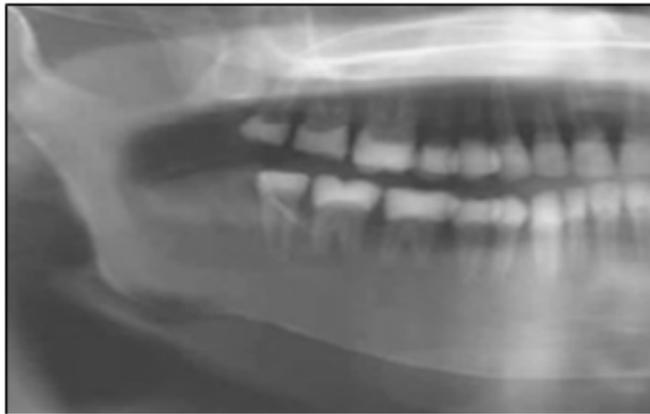


Figure (4): Panoramic radiograph showing underexposed film. adopted from; Iannucci and Howerton (Iannucci, 2017).

Contamination

The Contamination of chemical solutions show undesirable marks on the radiographic film, a developer material will result in dark marks, on the other hand a bright or white marks will be caused by contamination with fixer material (Anil, 2016). Any radiograph with poor quality lead to misinterpretation, resulting in incorrect clinical diagnosis and treatment planning. As a result, these radiographic images have to be repeated again for no inherent limitation of the equipment, but rather the result of operator's skill loss and patient preparation and positioning errors (White and Pharoah 2019). Digital panoramic imaging software usually have a histogram tool and adjustment tools for brightness and contrast. Some tools also allow adjustment of the gamma value. Changing these values will improve the

image contrast in either the brighter or the darker region of the image. Adjustment of brightness, contrast, and gamma value alter the original intensity data of the image (input) to new data (output). There is a possibility to exist permanent or temporary changes that can be restored to the image to its original settings. The digital processing techniques will reduce the processing errors, for a good quality radiographic image a particular attention should be given on operator training and patient preparation and positioning. Good quality panoramic image not only inhibits misinterpretation that makes wrong diagnosis and treatment planning but, also increases the patient benefits by minimizing the radiation dose and cost (White and Pharoah 2019; Dhillon et al, 2012).

Important consideration to deal with panoramic radiographic errors:

- There are specifications that apply to all panoramic machines regardless of design:
- Patients should be asked to remove any jewelry, earrings, hairpins, spectacles, dentures or orthodontic appliances.
- In order to reassure the patients, all the details of the procedure and equipment must be explained,
- Lead aprons, which are meant to safeguard workers, should be avoided since they might detract from the final image.
- The operator must place the patients perfectly by using the available light marker guidelines.
- Patients should be instructed to place their tongue on the roof of their mouth.
- All patients should be instructed not to move during the exposure cycle
- Appropriate exposure parameters should be selected
- For the children under 5 years old panoramic tomography is considered

unsuitable because it requires keeping still throughout the exposure cycle. (Peretz, 2012; Suomalainen, 2015; Rondon, 2014)

Conclusion

All the clinicians who deals with panoramic radiography should have full knowledge of proper panoramic mechanism and adhere the guidelines of manufacturer offering a diagnostic image and to get all the benefits of panoramic radiography such as a large FOV for both jaws with their supporting structures and minimal radiation dose. The radiologist have to make any attempt to lessen the errors due to patient preparation, positioning, and technical that produce a deformed and undiagnostic image.

Conflict of interest

We are the author's (Zainab M. Al-Bahrani) state that the manuscript for this paper is original, and it has not been published previously (or part of MSc. dissertation or PhD thesis) and is not under consideration for publication elsewhere, and that the final version has been seen and approved by all authors.

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Zainab M. Al-Bahrani

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