

Panoramic Radiography : Understanding The Most Widely Used Tool in Dentistry

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Introduction

The term "panoramic radiography" is derived from panorama, 'an unobstructed view of a region in every direction' that is displaying of entire upper and lower dental arches on a single film. It is a radiographic technique that has become an essential diagnostic procedure in many hospitals and modern dental offices. There are certain limitations of the intraoral radiographs for overall coverage of the maxillomandibular structures. The conventional extraoral radiographs can achieve better coverage, but these radiographs shows distorted images, lack of definition and superimposition of the anatomic structures. The panoramic radiography has overcome many of the limitations of the above-mentioned techniques. In panoramic radiology, the dose to the patient is approximately 10 times less than the full mouth survey. The panoramic dose is about equal to that of four bitewings using the long rectangular cone and E+ film. Thus, in the general practice of dentistry the panoramic radiographs replace the "full series" of X-rays (periapical films).^{1,2,3,4}

Keywords: Panoramic Radiographs, Centre of Rotation, Focal Trough

Indications

- Presence of the large lesions such as cyst, tumours and developmental anomalies in the body and rami of the mandible to establish their site and size.
- Fractures of all parts of the mandible except the anterior region.
- **Antral Disease** : Particularly to assess the floor, posterior and anterior walls of the antrum.
- **Orthodontic Assessment** : To note the presence and position of the developing permanent dentition.
- **Periodontal Disease** : As an overall view of the alveolar bone levels.
- Investigations of the quality of the articular surfaces of the condylar heads in TMJ disorders.
- Assessment of the presence and position of the wisdom tooth.
- Assessment of any underlying disease before constructing complete or partial denture.
- Evaluation of the vertical height of the alveolar bone before inserting Osseo-integrated implants.

Advantages^{5,6}

1. Wide coverage of the dental arches and

2. Production of relatively undistorted anatomical images.
3. Significantly reduced dosage to the patient.
4. Simplicity and rapidity of the procedure.
5. Reduced superimposition of the anatomical structures.
6. Minimal infection control procedures.
7. Possibility of detecting caries, periodontal diseases and pulp-associated periapical changes.

Limitations³

1. **Image Quality** : The images seen on a panoramic radiograph are not as sharp as those on an intraoral radiograph because of the intensifying screens.
2. **Focal Trough Limitations** : The objects of interest that are located outside the focal trough are not seen.
3. **Distortion** : Even when the proper technique is used, a certain amount of distortion and overlapping is present on a panoramic radiograph.
4. **Equipment Cost** : The cost of the panoramic X-ray unit is relatively higher than that of intraoral X-ray unit.

Principles of the Panoramic Radiography^{5,1}

The rotational panoramic radiography is characterized by rotating a narrow beam of radiation in the horizontal plane around an invisible rotational axis that is positioned intra-orally. A vertical narrow X-ray beam is used in rotational radiography as compared to much larger circular or rectangular X-ray beams used in conventional intraoral radiography.

Projection in the Vertical Plane

The vertical dimension of the panoramic image is the result of a conventional radiographic projection, so it is unaffected by the horizontal rotation of the beam. Therefore, the focal spot in the X-ray tube anode serves as the functional focal spot for the vertical aspect of the projection. There is a slight negative angulations (about 4° to 7°) so that the X-ray beam will pass beneath the occipital portion (base) of the skull.

Projection in the Horizontal Plane

The horizontal dimension of the panoramic image is offered by the horizontal rotation of the beam. In this, the X-rays appear to diverge from an intraoral source although they really originate outside the patient at the focal spot of the X-ray tube. Thus apparent intraoral X-ray source is called the centers of radiation and is, called the

"effective focal spot of the projection".

Role of the Moving Film

In rotational panoramic radiography, the film is not stationary. Instead, the film is attached to the rotating system and moves in the same direction as the beam although at a slower speed. The film is given the correct speed by opposing the movement of the beam with a contrary movement of the film relative to the beam. This does not affect the central projection of the object but it affects the length of the image recorded on the film, so that the image is foreshortened in the direction of the movement. To reduce the horizontal magnification, the speed of the moving film is carefully chosen until it just matches the vertical magnification for one particular curved plane within the object.

Principles of Panoramic Image Formation¹

It was first described by Hisatugu Numata (1933) and Paatero (1948).¹ The principles of panoramic radiograph can be understood by considering the following illustrations-

First Illustration

Consider two adjacent disks rotating at the same speed but in opposite direction. The X-ray beam is directed through their centers of rotation. The lead collimator is in the shape of a slit, located at the X-ray source and film. This will limit the central ray to a narrow slit beam. The objects A,B,C,D on disk 1 rotate

past the slit, and their images are recorded on the film, i.e.; disk 2. The objects will be sharply revealed on the film because they are moving past the slit at the same rate as the film.

Second Illustration

Here, both X-ray source and the film move in opposite direction at the same speed at one fixed center of rotation. In this, X-ray source is rotated so that the central ray constantly passes through the center of rotation of disk 1 and simultaneously both disk 2 and lead collimators rotate about the center of disk 1. Optimum image definition is displayed when the speed of disk 2 (film) equal to that of the X-ray source which passes through the objects A,B,C,D on disk 1.

Third Illustration

In this, the disk 1 may be replaced by a patient. During the exposure cycle, the machine will automatically shift to the other rotation center. The movement of the film is equal to the speed of the X-ray source that passes through the dental structures of the patient near the film. The structures near the X-ray tube are distorted and magnified so that they blurred-off as they are in out of the focus area. The structures appear only as diffuse phantom or ghost images. Thus, only structures near the film will be usefully imaged on the resultant radiograph.^{7,10}

Most panoramic machines now use a continuously moving center of rotation. This optimizes the focal through shape to display the teeth and supporting bone. Initially, the center of rotation is near the lingual surface of the right body of mandible, when the left TMJ is imaged. The center of rotation then moves forward along the arc that ends just lingual to symphysis of the mandible, when the midline is imaged. The opposite side of the face is imaged when the arc is reversed.

Focal Trough

The Focal trough (also known as the image layer) is a three-dimensional curved zone in which structures are clearly demonstrated on a panoramic radiograph. The structures located within the focal trough appear reasonably well defined on the resultant panoramic radiograph. The structures positioned inside or outside of the focal trough appear blurred or indistinct on the resultant radiograph.⁵

According to the manufacturer of the panoramic X-ray unit, the focal trough varies. The closer the rotation center is to the teeth, the narrower the focal trough. In most

panoramic X-ray machines, the focal trough is narrow in the anterior region and wide in the posterior region.

Each manufacturer provides specific instructions about patient positioning to ensure that the teeth are positioned within the focal trough. A comparison of three panoramic X-ray machines revealed that the focal trough of the panorex curved inward in the posterior region, that of the GE-3000 remained straight, and that of the ortopantomograph flared outward. The panorex was found to have the widest trough in the anterior region; the GE-3000 had the widest trough in the posterior region. Physical deviation of the location of the structures from a position at the center of the focal trough may result in a change in size or shape of the recorded image and the introduction of the spatial distortion. If the object or the patient's jaw is positioned anterior to the focal trough, it will result in decreased width of the images of the teeth (overlapping of tooth). Images appeared increased in width (magnification of tooth) when the object lies posterior or behind the focal trough.^{8,2}

Equipment Preparation

Because of the increase in panoramic radiography it is important to know if image quality has improved with recent technical developments and if there are differences between the different machines that can justify the difference in price. The dental radiographer must complete equipment preparation prior to preparing a patient for the exposure of a panoramic film.

- The cassette is loaded in the darkroom under the safelight conditions with one extraoral film and two intensifying screens, and the cassette must be closed securely.
- The bite-block must be sterilized in between the patients.
- Set the exposure factors i.e., kilovoltage, milliampere according to the instructions of the manufacturer.
- Adjust the machine according to the height of the patient.
- Then, the cassette is loaded on the cassette carrier of the panoramic unit.

Image Receptors

The screen film and intensifying screen combination is used in panoramic radiography. This reduces the amount of radiation required for exposing a radiograph. In most cases, fast films with high speed

(rare-earth) screens are used. Sometimes, panoramic machines with intensifying screens can be provided by the manufacturer.

In new panoramic machines, a linear charge-coupled device (CCD) sensor or photostimulable phosphor (storage phosphor) screen replaces the film screen combinations. This system produces digital panoramic images.¹

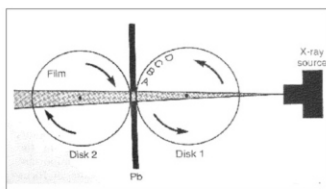
Patient Positioning

The patient's head should be positioned correctly in the panoramic machine so that the jaws and teeth are within the focal trough.

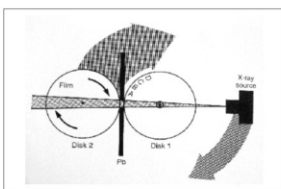
- Removal of the glasses, metallic items such as earrings, necklace, hairpin, nose ring, hearing aids and dental appliances.
- Lead apron: if a lead apron is used, it should not have a thyroid collar because such collar will block the primary beam.
- Instruct the patient to sit or stand with the back straight and erect. The vertebral column must be perfectly straight.
- The patient's head should be tilted slightly downward so that the occlusal plane should be angled 20 to 30° below the horizontal.
- **Bite-block Position** : The anterior teeth should be positioned in the proper groove in the bite-block and not forward or posterior to the groove. If the patient is edentulous, the upper and lower ridges must be aligned over the notched area on the bite-block to provide stabilization for the patient.
- **Midsagittal Plane** : This plane should be perpendicular to the floor.
- **Frankfort Plane** : This is an imaginary line connecting the floor of the orbit and the external auditory meatus. This plane should be parallel with the floor. Because of this, the occlusal plane is positioned at the correct angle.
- **Chin Position** : The chin should not be angled up or down.
- **Head Position** : The head positioning devices should be firm to prevent the tipping or rotating during the exposure.
- **Patient Movement** : Instruct the patient not to move during the exposure otherwise a blurred image will result.
- **Tongue Position** : instruct the patient to swallow and position the tongue on the roof of the mouth. Also instruct the patient to close the lips around the bite-block.

References

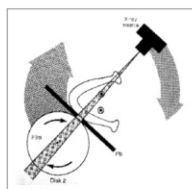
References are available on request at editor@healtalkht.com



Movement of the film and object about two fixed centers of rotation



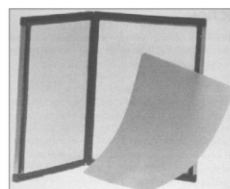
Movement of the film & X-ray source about a shifting center of rotation



Movement of the film & X-ray source about a shifting center of rotation



Panoramic Machine



Cassette & Intensifying Screen



Patient positioning in panoramic radiography