Panoramic Radiographs Technique & Anatomy Review

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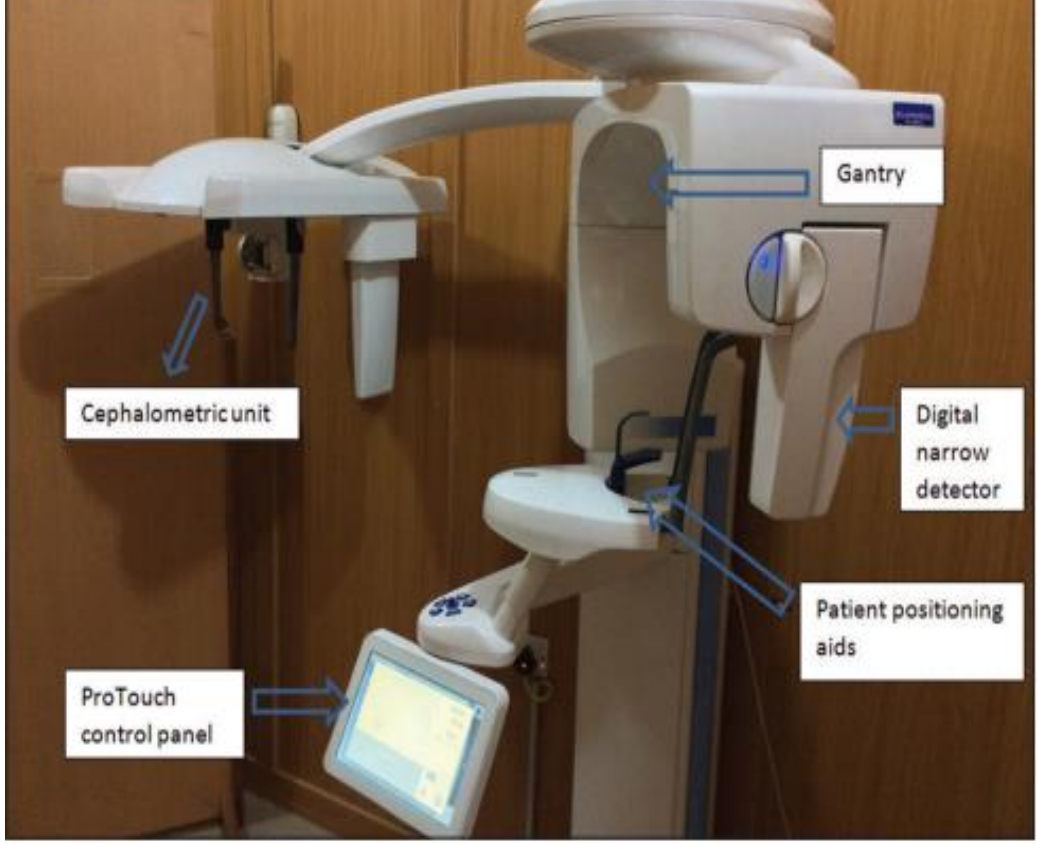
Panoramic radiography:

Panoramic radiography is widely used in dentistry and was considered a significant breakthrough as both jaws, together with the dentition, are imaged with a quick and straightforward procedure.
It has a wide variety of uses requiring **broad coverage of the jaws**, including traumatic fractures, impacted third molars, dental problems or bony diseases, **evaluation of tooth development**, temporomandibular joint pain and **other anomalies.**
Distinct soft tissue, bony landmarks from midfacial to the chin region as well as the teeth can be seen in the radiograph.
Interpreting panoramic radiographs may be tricky especially for beginners, and this article will discuss the steps needed to read the wide sized black, white and grey image

Step 1: Assess the quality of the radiograph

Only good quality radiographs can be used for diagnosing dental-related problems. Poor quality radiographs are mainly caused by poor patient positioning and when patient's tongue was not held against the palate.



A dental student or a dentist should eyeball the panoramic radiograph making sure that the occlusal plane has a slightly curved arc, similar width of ascending ramus on both sides and a similar level of ghost shadow of the mandibular angle.
All areas of interest from the condylar head to the chin should be included in the image and the maxillary dentition roots should not be superimposed on the hard palate. Living in the digital age, some enhancement can be done to improve the image quality of the panoramic radiograph to aid visual examination and diagnosis. This enhancement is usually done by increasing the contrast and adjusting the brightness

Step 2: Know your normal anatomy

A good dentist should know the anatomy of the head and neck region by heart. Normal anatomy, double images, ghost images, and pathology must be categorised before formulating the diagnosis.

Step 3: View the radiograph in a sequenced, systematic approach

Several methods of reading the radiographs are described in the literature, either from left to right, top to bottom or spiral from outer border to the centre areas. A more preferred systematic approach for a beginner is the spiral method, with three swipes to cover the whole area.
The first spiral begins at the right condyle, moving down along the border of the mandible and up to the left condyle. Then, move anteriorly assessing the left maxillary antrum, the hard palate, nasal area and right maxillary sinus.
The second spiral begins at the right sigmoid notch area, then focuses on the periapical region of the mandibular teeth and continues with the periapical area of the maxillary teeth. The last part focuses on each tooth and alveolar bone area.[5] A systematic approach is essential to ensure all areas are covered in your interpretation and diagnosis

A panoramic image

A panoramic image displays the patient's **maxillary and mandibular oral and facial structures** across a flat surface.

panoramic imaging is an extraoral technique that is used to examine the maxilla and mandible on a single projection.

Panoramic imaging was first introduced in the **1930s**, but became more popular as a diagnostic tool in the **1960s**.During the 80s, panoramic imaging transitioned to a **digital format**, which had the advantage of **less radiation** as well as **immediate viewing of the image for patient education.**

Panoramic imaging enables the dentist to diagnose the entire dentition and facial structures that are not visible in a full-mouth series.

The technique is considered part of the standard of care and is popular due to the relative ease of use, **wide scope of examination**, and **low radiation dose**.

Guidelines presented by the American Dental Association (ADA) indicate that a panoramic image and posterior bitewings are considered an acceptable full mouth series in certain case

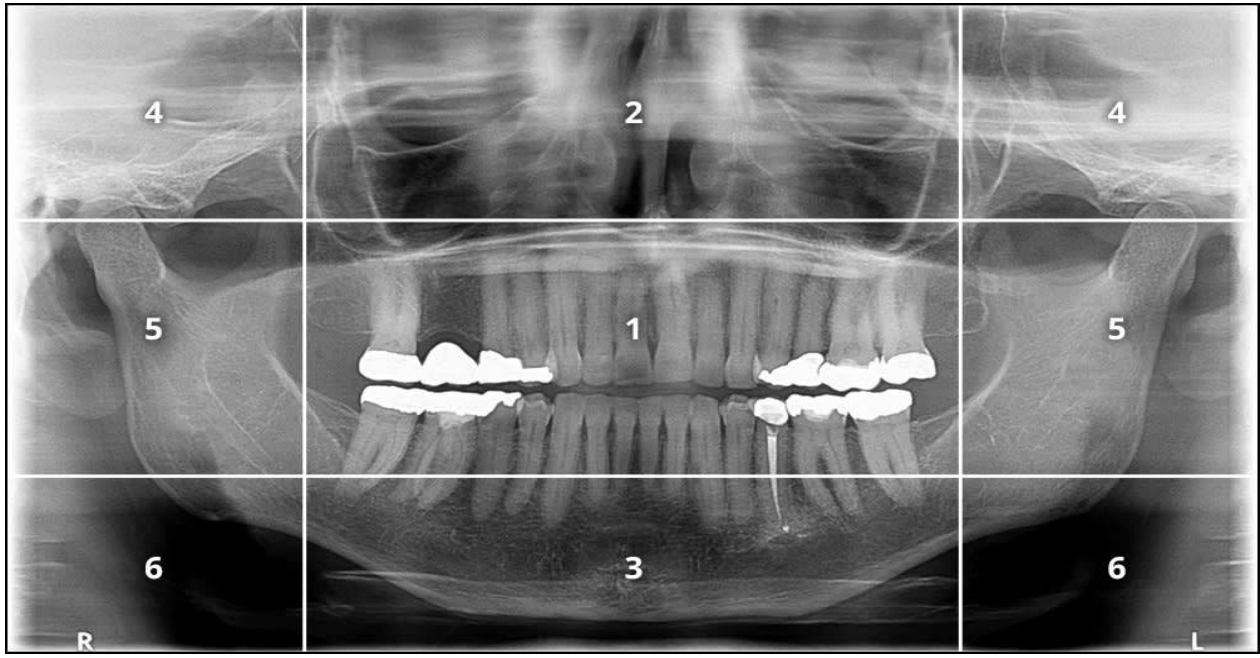
Dental professionals must understand the difference **between normal anatomical landmarks** and **abnormal findings**, such as **artifacts** or **pathology**, which may be present on a panoramic image when **viewing both the mandible and maxilla in the one projection**.

It is recommended to review the image systematically in order not to overlook anything that might be a deviation **from normal**.

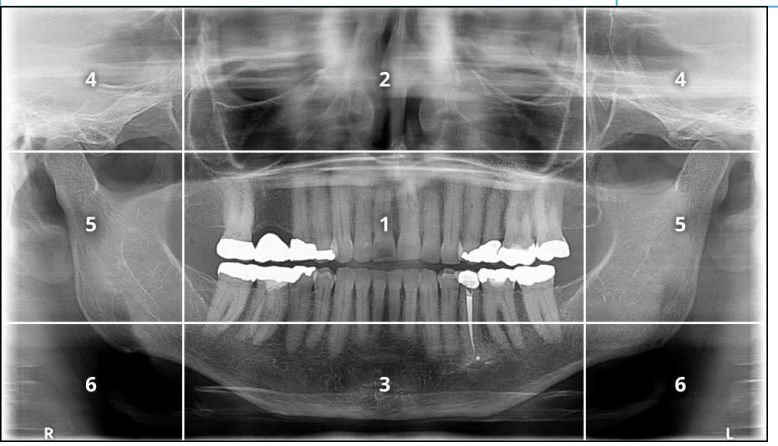
The clinician may **utilize the technique** that they are comfortable using; however, it must be consistent and ensure that **all diagnostic information is read**.

1) review osseous structures and surrounding soft tissues,
2) review the alveolar process, and
3) review the teeth

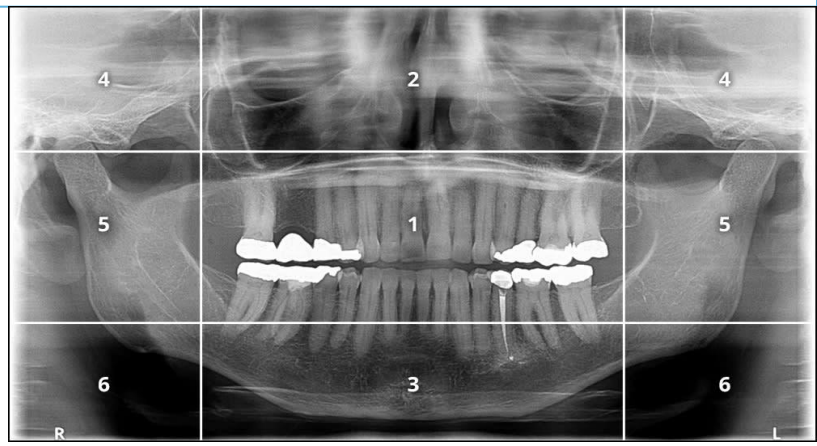
It is important to **evaluate the image bilaterally** to look for symmetry, or **asymmetry**, which can indicate a **pathological condition**. For that reason, the methods suggested by Langland, Langlais, and Preece, which divides the image into **6** different zones , is a valuable tool for use during interpretation



one 1: Dentition	•Teeth arranged with an upward smile-like curve •Anterior teeth should not be too large or small •Posterior teeth should be evenly sized without excessive overlap •Apices/crowns of teeth should be visible
Zone 2: Nose & Sinus	•Inferior turbinates and surrounding air spaces visible •Soft tissue of nose should not be visible •Shadow of hard palate will be seen in maxillary area •Tongue should be in contact with hard palate
Zone 3: Mandibular Body	•Inferior border of mandible should be continuous and smooth •Ghost image of hyoid should not be visible •Midline area should have proper proportions
Zone 4: Condyles	•Condyles should be centered within the area of the zone •Condyles should be of equal size and on same horizontal plane
Zone 5: Ramus & Spine	•Ramus of mandible should be similar width bilaterally •Spine, if seen, may be present as long as it doesn't superimpose over the ramus •If spine is present, the distance between the ramus and spine should be equivalent on both sides
Zone 6: Hyoid Bone	•Hyoid bone should appear as a bilateral, double image with equal proportions •Hyoid image may touch the mandible, but should not spread across it



Zones of Panoramic Image Interpretation



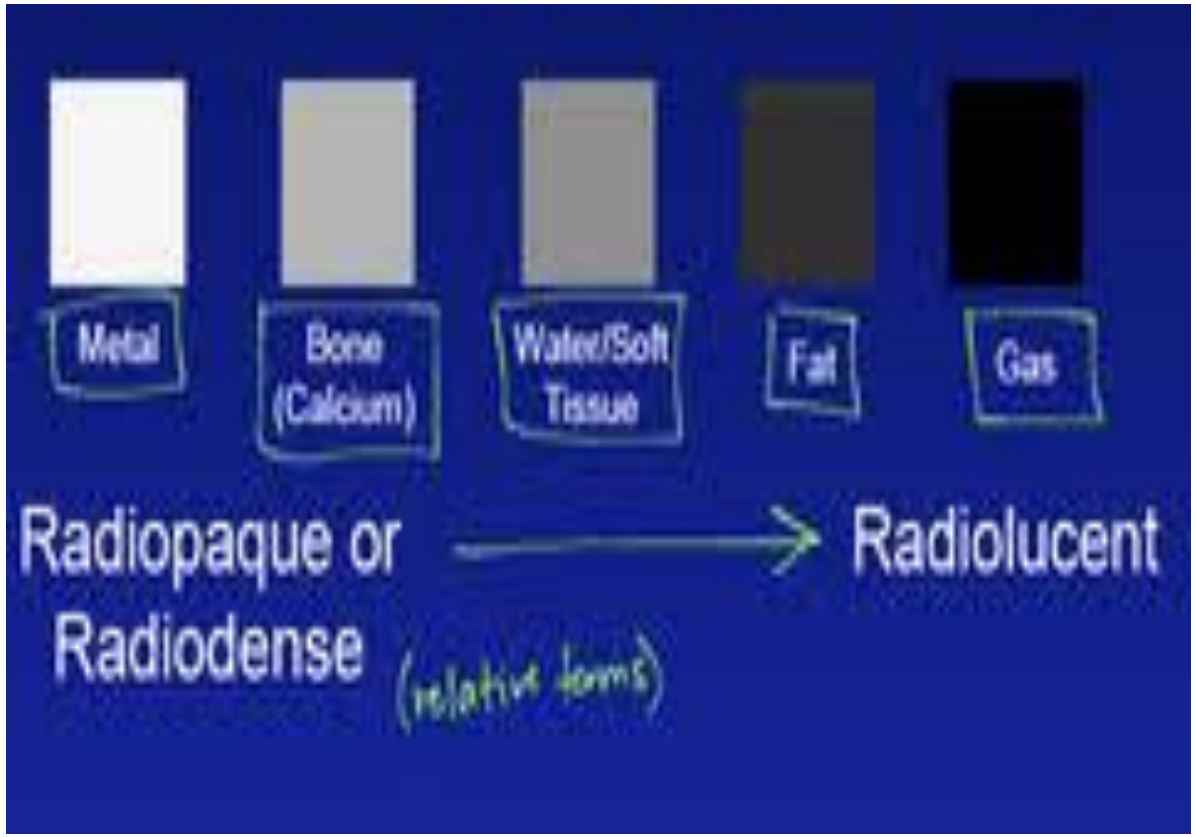
Glossary

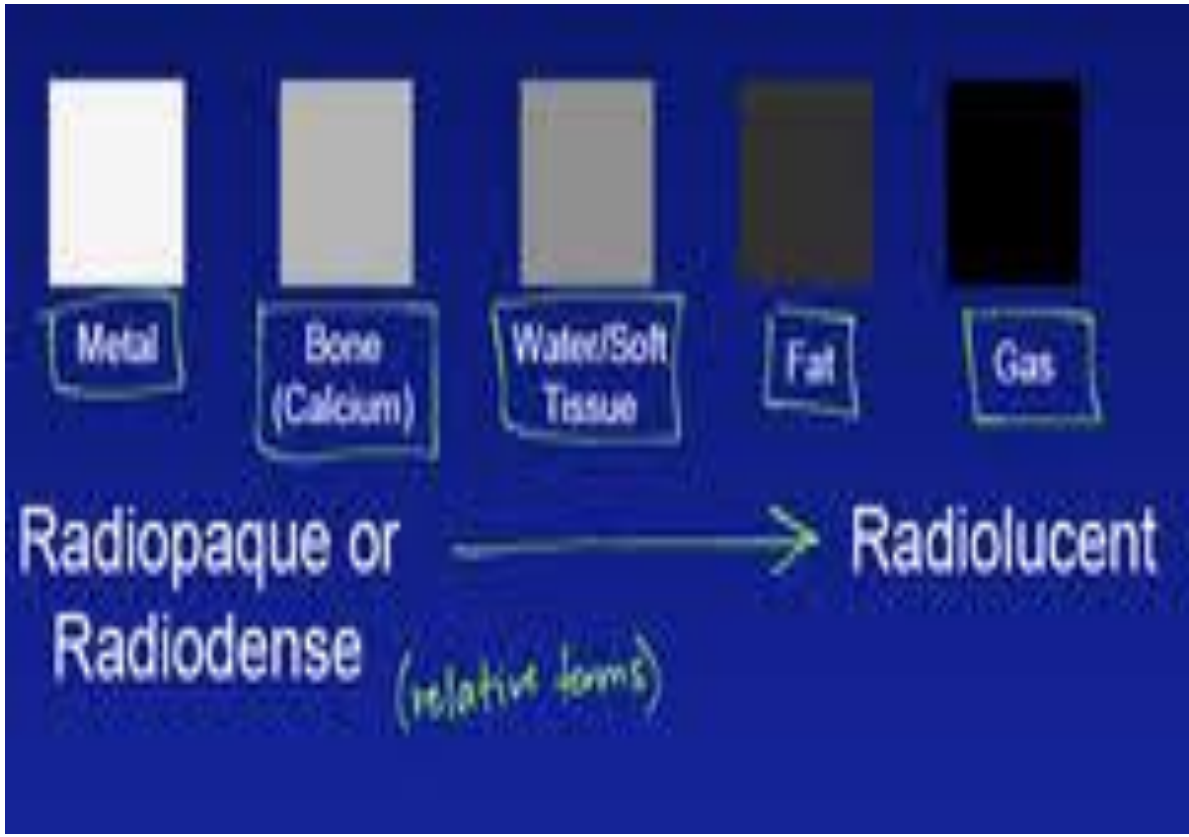
Radiolucent

– Refers to structures that are less dense and permit the x-ray beam to pass through them. Radiolucent structures appear dark or black in the radiographic image.

Radiopaque

– Refers to structures that are dense and resist the passage of x-rays. Radiopaque structures appear light or white in a radiographic image





BONY LANDMARKS[1]

Anterior nasal spine – a radiopaque V-shaped structure in the maxilla that intersects the floor of the nasal cavity and the nasal septum.

External auditory meatus – a round radiolucent passage way to the ear (bilateral).

Genial tubercle – a round/oval radiopaque structure inferior to the mandibular incisors.

Hard palate – a radiopaque bony structure that separates the nasal cavity from the oral cavity.

Internal oblique ridge – a radiopaque structure which is located on the internal surface of the mandible and proceeds downward to become the mylohyoid ridge (bilateral).

Maxillary sinus – a radiolucent area located above the apices of the maxillary premolars and molars. The floor of the maxillary sinus often appears as a thin wavy radiopaque line (bilateral).

Mandibular canal – a radiolucent tube-like structure outlined by two radiopaque lines that starts at the mandibular foramen and proceeds to the mental foramen (bilateral).

Mandibular condyle – a rounded radiopaque structure, which extends from the ramus and articulates with the glenoid fossa (bilateral).

Mental foramen – a round/oval radiolucent structure inferior to the mandibular premolars (bilateral).

Nasal septum – a radiopaque vertical bony structure that divides the nasal cavity into two.

Orbit – a radiolucent area superior to the maxillary sinus (bilateral).

Styloid process – a long, pointed radiopaque structure that extends from the temporal bone anterior to the mastoid process (bilateral).

Submandibular fossa – a radiolucent area toward the middle of the mandible that lies inferior to the mylohyoid line (bilateral).

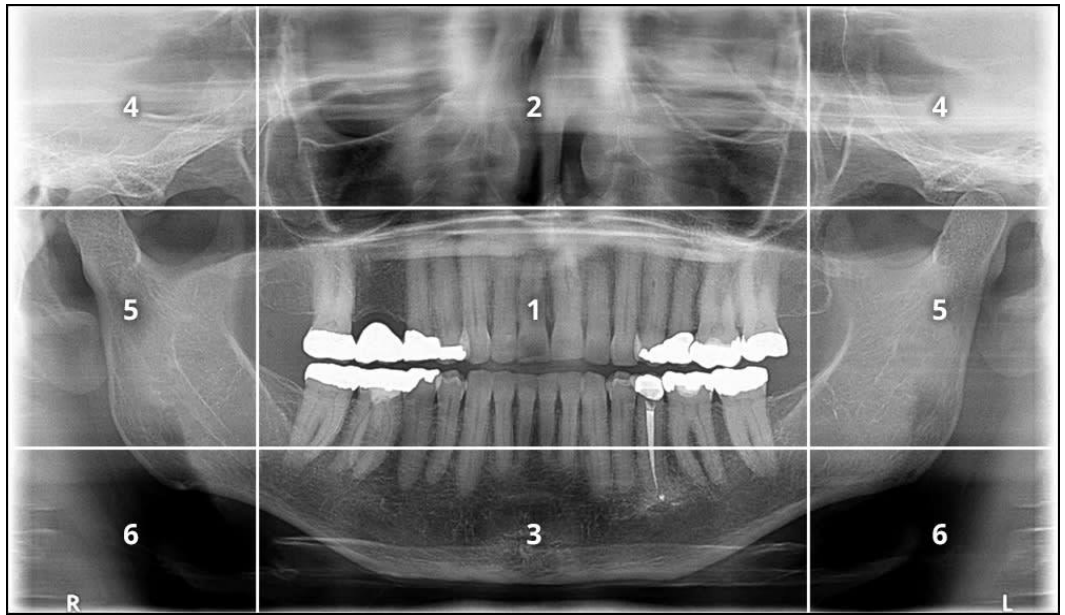
Zygomatic process – a "J or U" shaped radiopaque structure in the maxilla that lies superior to the maxillary first molars (bilateral).

AIRSPACES

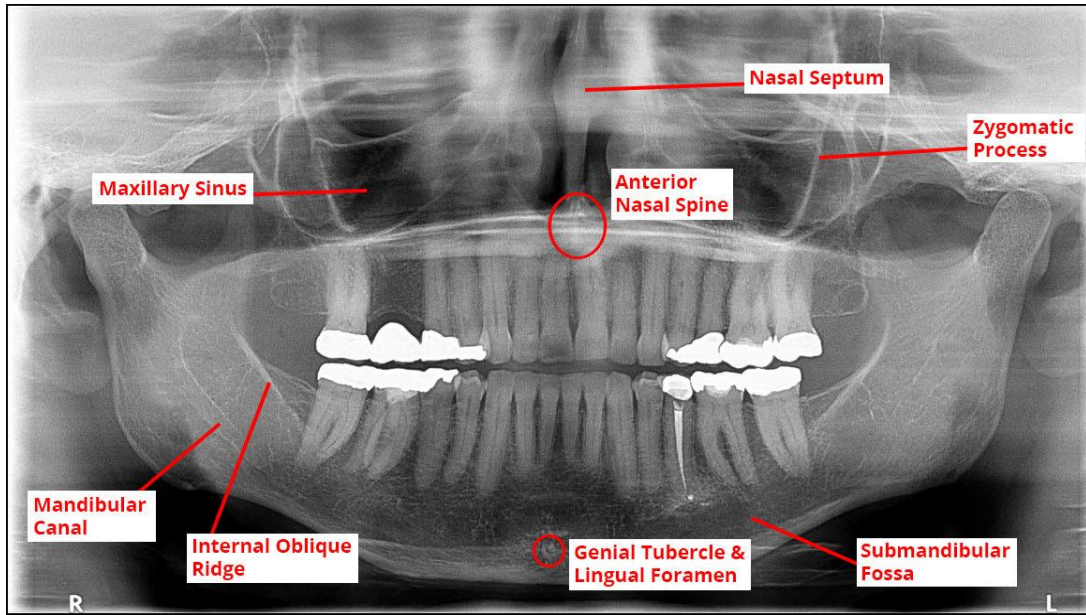
Nasopharyngeal air space – a radiolucent area that extends from the nasal cavity to the pharynx.
Glossopharyngeal air space – a radiolucent area that extends posteriorly from the tongue and oral cavity to the pharynx.
Palotoglossal air space – a radiolucent band that lies superior to the apices of the maxillary teeth and inferior to the hard palate.

Review of Normal Anatomical Landmarks and Variations

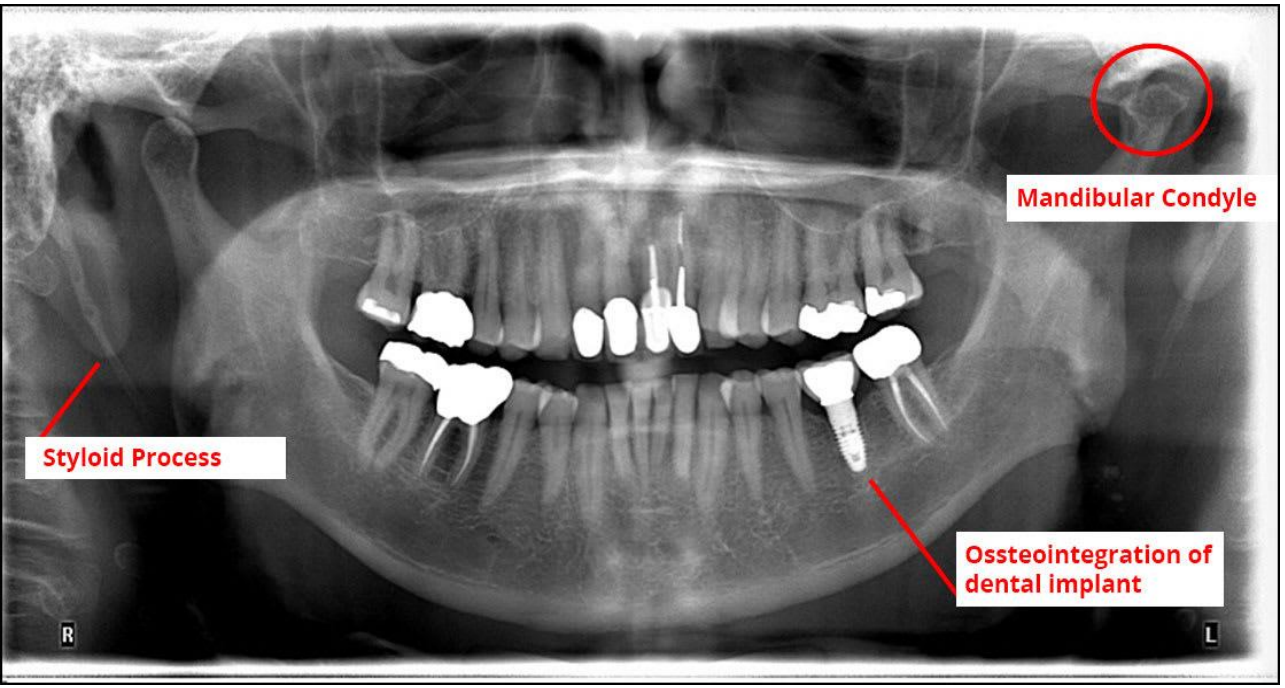
It is important to understand the landmarks normally seen on panoramic images in order to prevent misdiagnosis of a radiopaque or radiolucent area.
we will focus on the structures that are most commonly viewed in panoramic images.



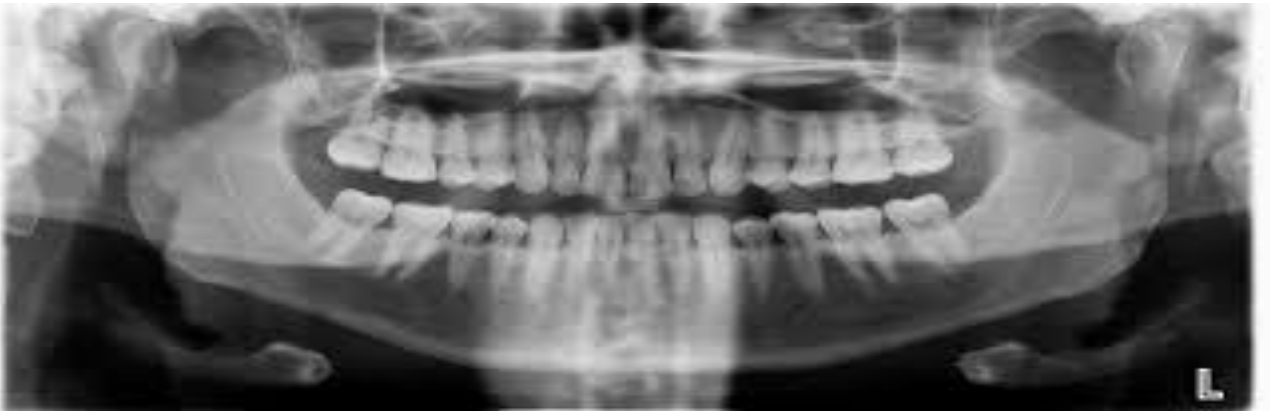
Normal Anatomical Landmarks



Example of Pathology and Variations of Normal.



The patient's chief complaint was pain and popping near the TMJ. The panoramic image indicates a flattened condyle and significant wear of the glenoid fossa of the temporal bone due to constant force from bruxism and clenching. It was also noted that the patient has very pronounced styloid processes (bilaterally)



OPG Technique

- Equipment Preparation
- Patient Preparation
- Patient Positioning

Equipment Preparation:

As with any dental procedure, it is important to properly prepare the equipment beforehand. Equipment preparation includes items such as the receptor, bite block, exposure settings, and patient selection .

If the panoramic image is being taken with a direct digital system, which transfers the image directly to the computer, it is important that the proper patient is selected in the electronic health record prior to the exposure. Otherwise, the image will be stored in the wrong location.

Setting the proper exposure time prior to beginning the procedure will help improve efficiency and reduce the possibility of over-exposing the patient to unnecessary radiation.

It is wrong to use same exposure time for all patients .In order to properly protect patients, the exposure setting must be tailored for each individual patient.

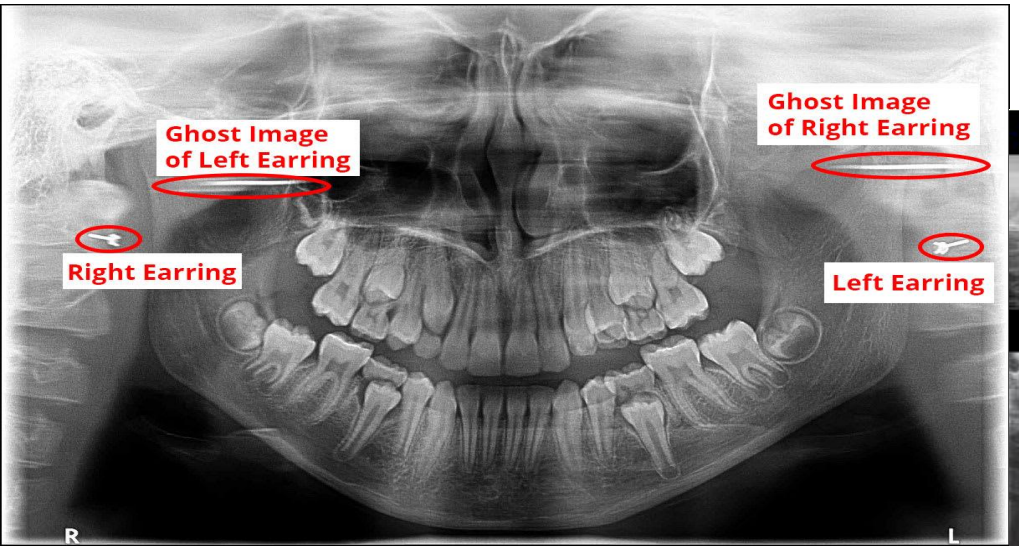
Most machines have settings that can be adjusted according to the stature of the patient. For example, when imaging a pediatric patient, the child exposure setting should be selected. Exposure settings should be adjusted accordingly as height and mass increases. There are usually two settings available for adult patients and one for children, which makes it possible to tailor the amount of radiation being produced.

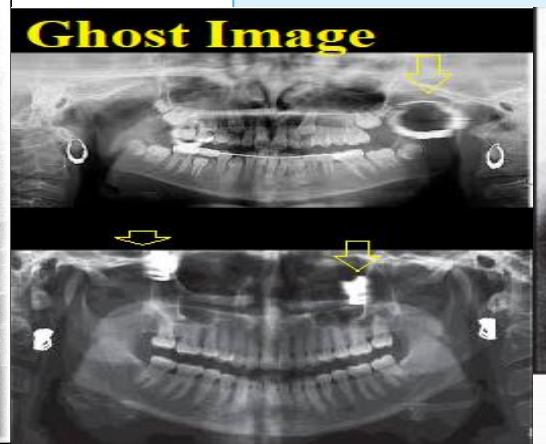
Patient Preparation

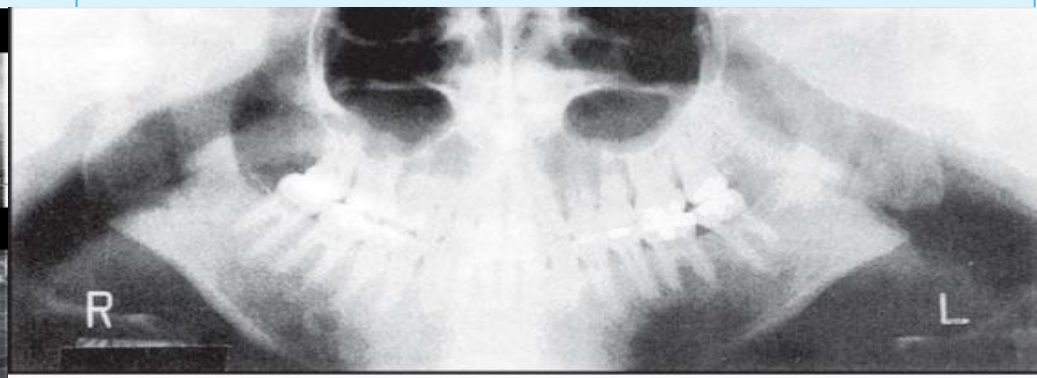
Patient preparation is extremely important for ensuring that a high-quality image is produced and that errors are avoided .

For instance, incorrect patient preparation can lead to "ghost images" which can render the radiographic image undiagnostic. While ghost images often occur due to metallic objects, they can also occur due to anatomical structures located outside the image layer or focal trough. Ghost images always appear higher and distorted on the opposite side of the radiographic image .Some errors are unavoidable due to the patient's stature, facial asymmetry, or difficulty following instructions

Receptor	**Analog/PSP plate placed in cassette according to guidelines.**
Select patient	**Direct digital sensor – have the correct patient assigned in computer before setting up.**
Bite-block	**Cover with disposable plastic covering or use a sterilized bite block made of impervious material between patients.**
Exposure Settings	**Set according to the manufacturer's recommendations, which are pre-programmed according to the size of the patient. Most machines have a single setting for pediatric patients and two options for adult patients (according to their size). Newer machines do not require that the clinician selects specific exposure times and doses for each patient.**
Height	**Adjust entire machine to the correct height for the patient and any other moveable parts as necessary.**



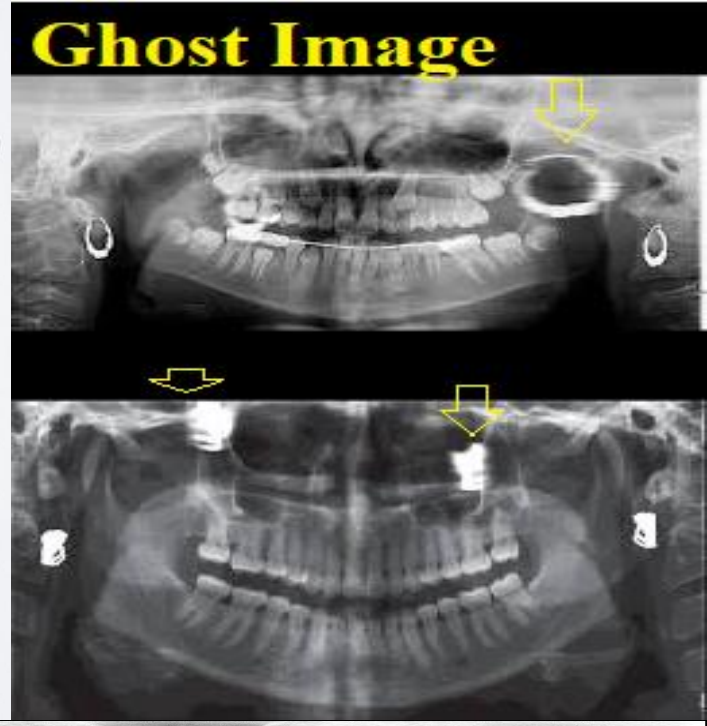




An exaggerated smile seen on a panoramic film when the patient's chin is tipped down

Patient Preparation Guidelines

Jewelry	**All necklaces, piercings (earrings, tongue rings, etc.) and jewelry in the head and neck regions need to be removed prior to exposure.**
Metal objects	**Items such as headbands, bobby pins, hair clips, hearing aids, etc. must be removed prior to exposure. Removable partial dentures and orthodontic appliances should be taken out prior to imaging.**
Lead Apron	**Apron must not have a thyroid collar and should be placed properly so it does not block the x-ray beam.**



The **patient's earrings** were not removed prior to imaging. Therefore, **a ghost image is present**. In the example, the image of the actual left earring is on the right side and the ghost image of the left earring is on the left side of the image. Ghost images appear distorted, higher, and on the opposite side of the panoramic radiograph. The other error that can be observed in the panoramic image, is that the chin is too low. **This causes the spine to be more pronounced on both sides of the image**

An important item to include when preparing the patient is the use of a lead apron, which is recommended for all radiographic procedures.

Lead aprons help provide protection for radiosensitive tissues in the neck, chest, reproductive areas, and blood forming tissue. In addition, lead aprons stop nearly 98% of scattered radiation from reaching reproductive organs. There are lead-free aprons that use an alloy material instead of lead.

They are 50% lighter and safer for patients and clinicians because they are **lead-free**.

While thyroid collars are not indicated for panoramic imaging, they are effective for use during intraoral imaging, because they have been shown to stop 92% of scatter radiation.

Patient Positioning

In order to obtain diagnostically useful images, patients must be positioned carefully within the image layer or focal trough, which is a three-dimensional curved zone .

Structures found within the image layer will be reasonably well-defined.The patient must be positioned correctly so that the proper structures are aligned within the image laye.

If patient positioning is incorrect, errors are likely to occur. Patient positioning errors are the most common type of error when performing panoramic radiography.

The most common patient positioning error occurs when the tongue is not placed close enough to the palate.This may be due to the patient misunderstanding the instructions and only placing the tip of their tongue on the palate. Incorrect positioning of the tongue creates radiolucency near the apices on the maxilla, which makes diagnosis of periodontitis and root resorption challenging.

It is helpful to note that each manufacturer provides specific operation instructions in the manual that accompanies the unit. It is worth the time and effort for each team member to become acquainted with the contents of the manual. While the instructions make panoramic imaging easy to perform well, it is equally as easy to perform badly when manufacturers' instructions are not

In panoramic radiography, the **x-ray source** and **the film are connected to each other.**

These two components rotate simultaneously around the patient to produce an image. The three-dimensional, horseshoe-shaped zone where images are sharp is called the **focal trough**, or **image layer.**

The panoramic radiograph is composed largely of the anatomic structures located within this **focal trough.**

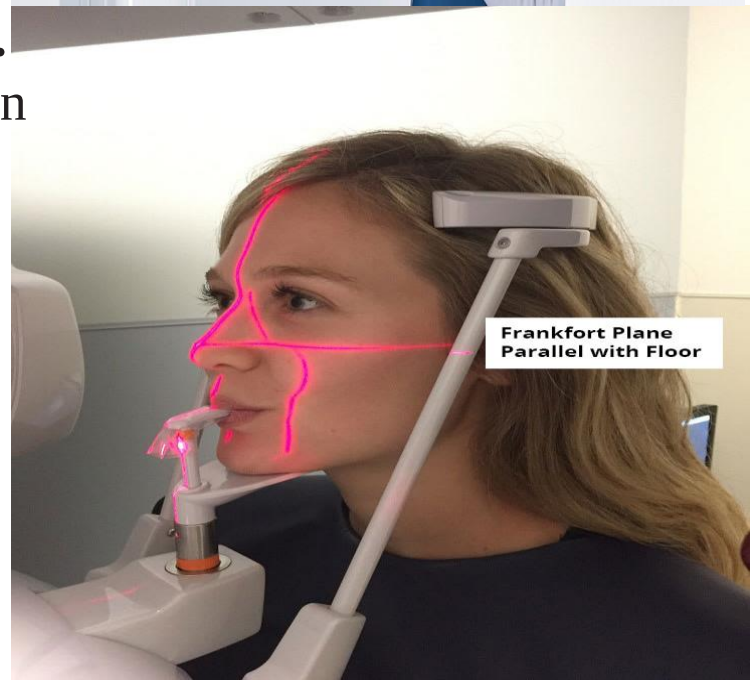
The focal trough is the area in which structures will appear most sharply and clearly.

Structures, which fall in front of or behind, the focal trough, can be distorted, magnified or reduced. The size and shape of the focal trough varies between manufacturers.

Patient positioning is important for obtaining a detailed panoramic radiograph.

Patients must be properly prepared and positioned with their head carefully aligned in the focal trough.

Since each panoramic machine is **slightly different**, the manufacturer's instructions should be **followed carefull.**



ADVANTAGES AND DISADVANTAGES:

Panoramic radiography offers several advantages over conventional intraoral radiography. Some of the main advantages are:

The broad anatomic region imaged, including additional visualization of the areas of the body of the mandible beyond the periapical region, the ramus, the temporomandibular joint, the maxillary sinus and the stylohyoid complexelatively low patient radiation dose.

One panoramic film generally delivers a radiation dose equivalent to about one set of four bitewing intraoral films.

Greater ease and **less time necessary** to produce a single image representing the patient's entire dentition.

The disadvantages of panoramic radiographs relate to these weaknesses:

Panoramic radiography is an extraoral technique and the resultant image does not resolve the fine anatomic detail **that may be seen on intraoral periapical radiographs.**

Magnification, **geometric distortion**, and **overlapped images of teeth sometimes occur.**

Objects situated outside the focal trough will be distorted or obscured on the radiograph.

The cost of a panoramic machine is approximately two to four times that of an intraoral x-ray machine.

COMMON ERRORS DURING PANORAMIC RADIOGRAPHY

Positioning errors

Anterior teeth positioned outside the focal trough will result in blurring of the anterior teeth. If teeth are positioned anterior to the focal trough, the occlusal plane will be increased, a generalized increase of overlap of tooth contacts occurs, and the anterior dentition will be demagnified (Fig. 2). However, if the anterior teeth are positioned posterior to the focal trough, they will be magnified and the occlusal plane will appear flattened (Fig. 3).

Midsagittal plane positioning error will occur if the patient's head is shifted to the left or right side. This will result in an asymmetrical and distorted image. The image of the structure farthest from the film will be magnified, whereas, on the opposite side, the structures' image closest to the film will be decreasedOcclusal plane positioning error will result if the patient's head is tilted up or down incorrectly. When the patient's head is tipped down, the resulting image will be shorter and the mandibular inferior border may be lost. The occlusal plane will be exaggerated and the anterior plane will be demagnified . If, however, the patient's head is tilted up, the occlusal plane will be flattened or even reversed (Fig. 6). There may be superimposition of the hard palate on the maxillary anterior tooth apices, a loss of density in the middle of the radiograph, and loss of either one or both temporomandibular joints.

Spinal column positioning error will occur if the patient is slumped. The resultant image will contain an unexposed area in the middle inferior portion of the film. If the spine is not kept erect, the spinal column, resulting in the low-density area near the lower centre of the film (Fig. 7) will excessively absorb the radiation.

Patient movement during panoramic radiograph exposure can result in a series of artifacts or distortion effects usually localized to one region of the radiograph, namely, the region the rotating beam was scanning when the patient moved

If placed improperly, lead apron shielding will produce an area on the film too dense to read due to the exposure of the lead apron

Ghost images are reflected images of a structure situated between the x-ray source and the rotation centre. Earrings are a common source of ghost image (Fig. 9).

Technical/processing errors

A fogged radiograph will appear gray or dark (Fig. 10). This is usually the result of old film, improper storage conditions, secondary exposure of film to x-rays, exposure to white light, exposure to wrong colour safelight or chemical fog.

If the image appears too light (thin), washed out or no detail is seen, this is usually due to underprocessing or underexposure. Some causes may be: x-ray beam energy level is too low and not producing enough radiation to properly expose the film; processing time in developer is too brief; chemicals are too cold or exhausted; or the processing temperature is too cold.

If the image appears too dark (dense) or no structures can be seen, this is usually due to the x-ray beam energy level producing too much radiation and overexposing the film; too much time spent in processing developer; high processing temperatures; or double exposure.

Tree-like static marks on the film are usually the result of crimped or creased film, localized overexposure, processing chemicals, or static electricity (Fig. 11).

Random white lines/artifacts appearing on the film may result from: lint or small pieces of debris between the film and screens; scratches or gouges on the intensifying screen; contact with fixer dust or solution (Fig. 12); or exposure error. Fingerprint artifacts may also result by contact with contaminated hands.

FIGURE 1. Diagnostic panoramic radiograph.

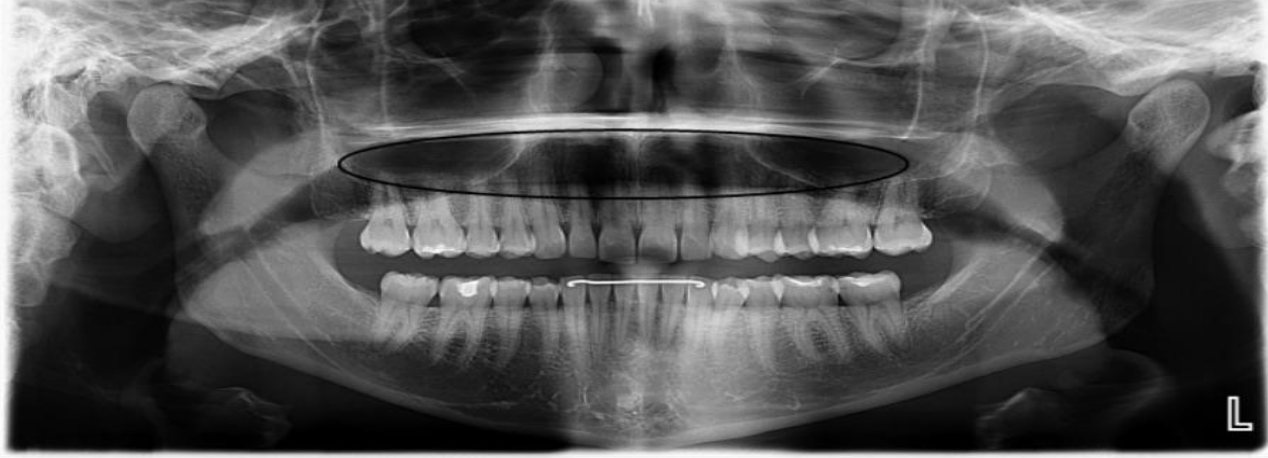


FIGURE 2. Panoramic radiograph with radiolucent artifact superimposed over the maxillary apices. The patient's tongue is not placed against the hard palate.

FIGURE 3. Panoramic radiograph with radiolucent artifact superimposed over anterior teeth. The patient's lips are not closed around the bite block.

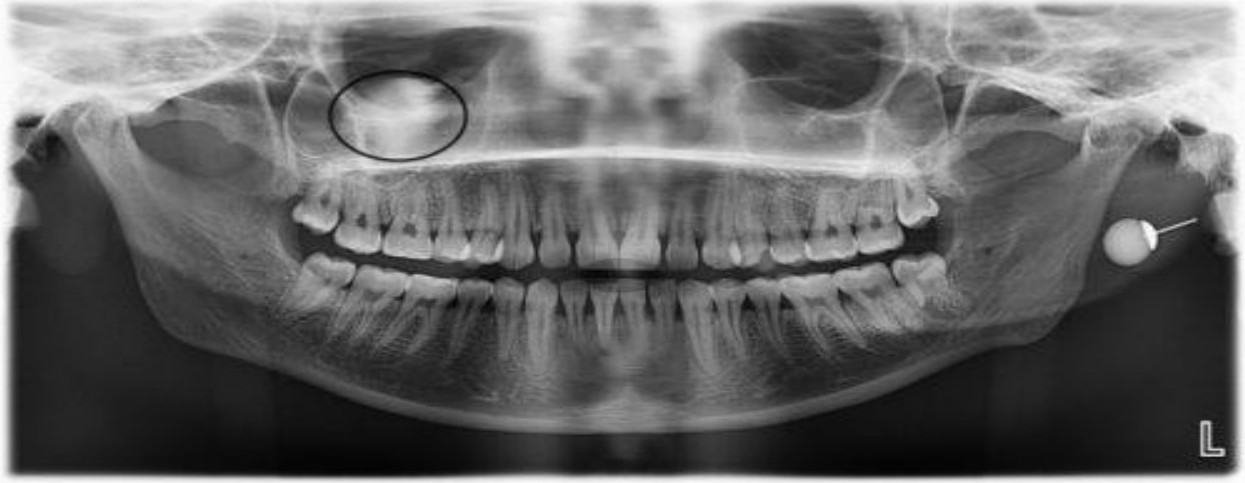


FIGURE 4. Panoramic radiograph with a ghost image from an earring. The real image of the earring is visible on the left side, while the ghost image is superimposed over the right maxillary sinus area.

FIGURE 7. Panoramic radiograph with two triangular radiopaque artifacts due to the lead apron placement above the patient's clavicles or too high on the patient's back.

FIGURE 8. Panoramic radiograph with narrow and blurry anterior teeth due to the patient positioned anterior to the focal trough.

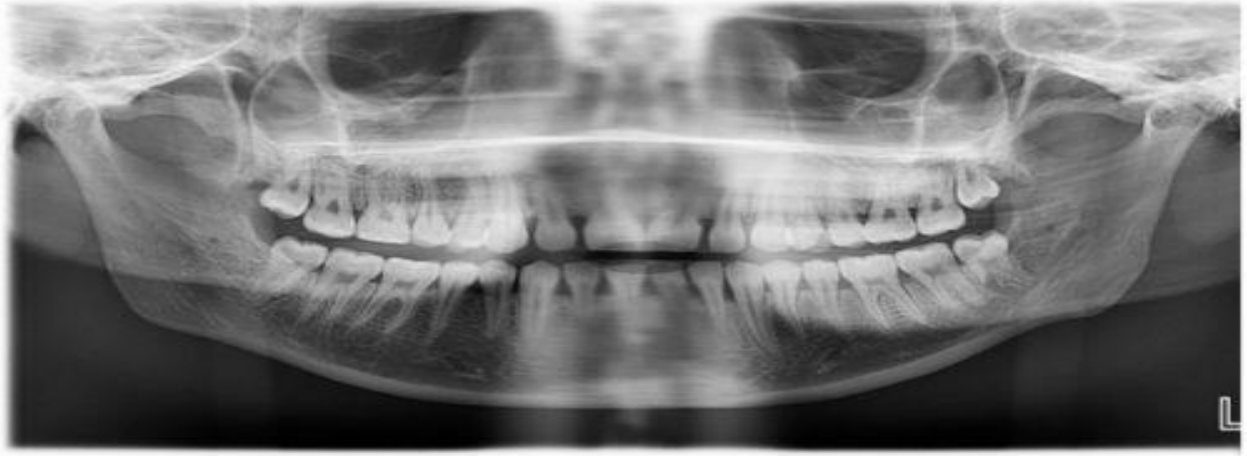


FIGURE 9. Panoramic radiograph with wide and blurry anterior teeth due to the patient positioned posterior to the focal trough.

FIGURE 10. Poor panoramic radiograph caused by patient's midsagittal plane not being positioned perpendicular to the floor. The left side of the radiograph is magnified due to the patient's head being tilted to the right.

CLINICAL IMPLICATIONS

Clinicians can prevent imaging errors by following proper radiographic technique. Studies have found 64% to 98% of panoramic radiographs evaluated had one or more errors.[16–]The most common error observed was the air space superimposed over the maxillary apices.

Errors will distort a radiograph.The nondiagnostic quality of these images ranged from 10% to 40%.Nondiagnostic radiographs may result in exposing patients unnecessarily to additional radiation.

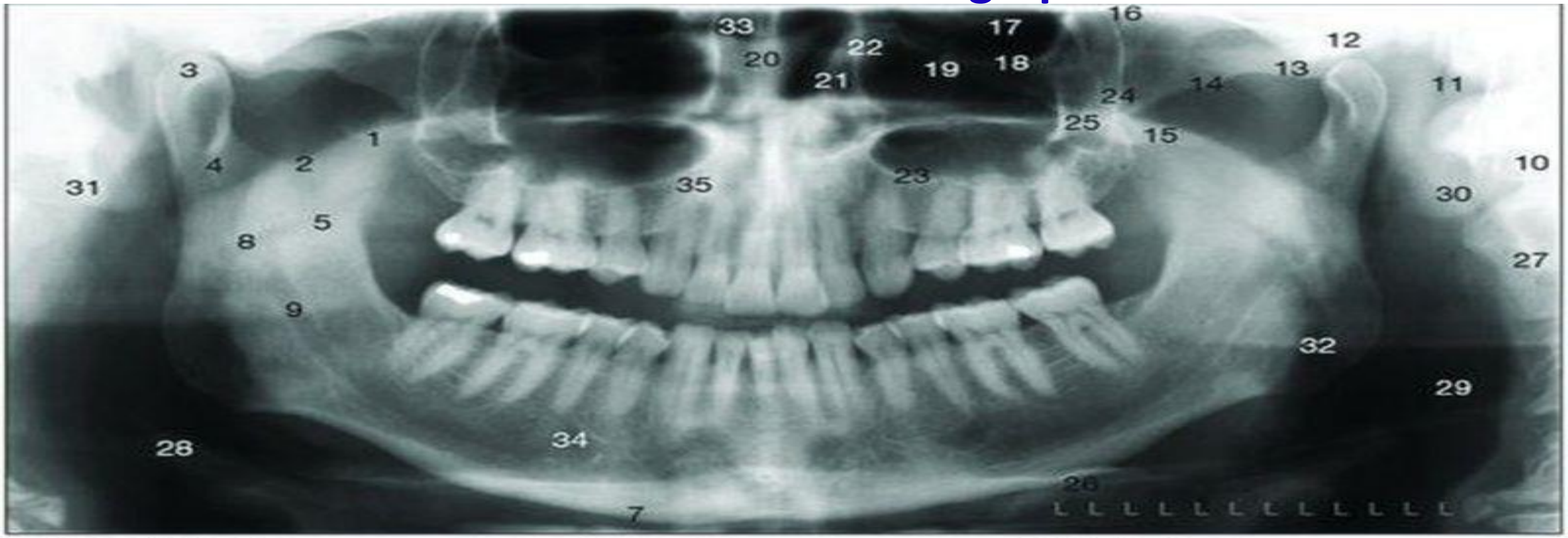
Individuals in the United States have an annual radiation dose of approximately **6.2 mSv, with 3.0 mSv** of this annual dose attributed to medical radiation.When comparing radiation exposure of digital dental radiographs, a panorex provides less exposure than a full-mouth series.

Four digital bitewings using rectangular collimation provides a radiation dose of 5 µSv.

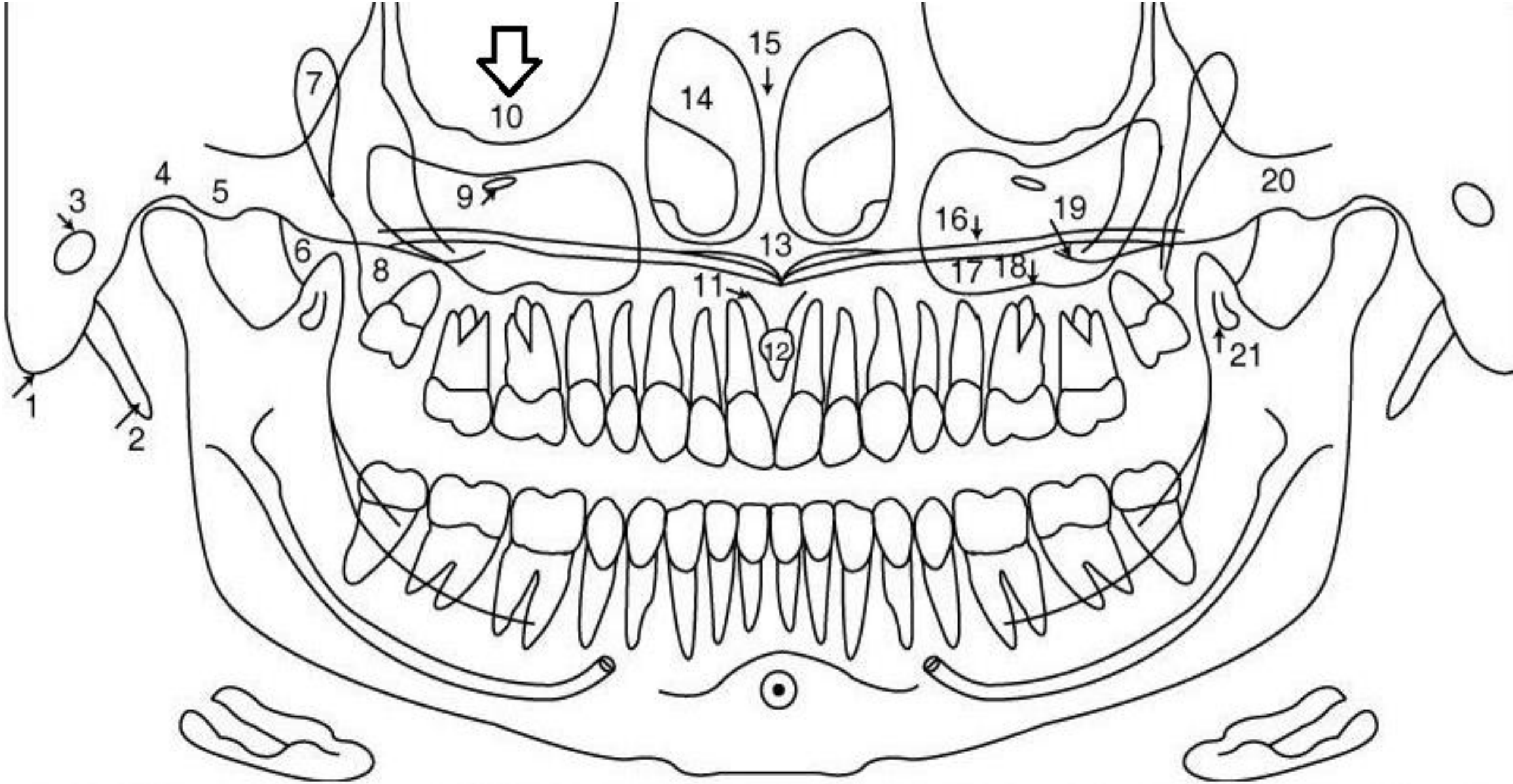
While these radiographic examinations expose patients to small amounts of radiation, clinicians should ensure images are of diagnostic quality to prevent additional radiation exposure.

A retake should only occur if the image is nondiagnostic and not to correct minor error

Anatomical landmarks on a Panoramic radiograph



1. Coronoid Process
2. Sigmoid Notch
3. Mandibular Condyle
4. Condylar Neck
5. Mandibular Ramus
6. Angle of Mandible
7. Inferior Border of Mandible
8. Lingula
9. Mandibular Canal
10. Mastoid Process
11. External Auditory Meatus
12. Glenoid Fossa
13. Articular Eminence
14. Zygomatic Arch
15. Pterygoid Plates
16. Pterygomaxillary Fissure
17. Orbit
18. Inferior Orbital Rim
19. Infraorbital Canal
20. Nasal Septum
21. Inferior Turbinate
22. Medial Wall of Maxillary Sinus
23. Inferior Border of Maxillary Sinus
24. Posterolateral Wall of Maxillary Sinus
25. Malar Process
26. Hyoid Bone
27. Cervical Vertebrae 1–4
28. Epiglottis
29. Soft Tissues of Neck (Look Vertically for Carotid Artery Calcification here)
30. Auricle
31. Styloid Process
32. Oropharyngeal Air Space
33. Nasal Air Space
34. Mental Foramen
35. Hard Palate




THANK
YOU!