L.9 # Image Characteristics

By

Mahmood Al-Fahdawi B.S., M.Sc., Ph.D.

Oral Radiology Teacher, Anbar University

Image characteristics:

Visual characteristics

Density

Contrast

Geometric characteristics

Sharpness

Magnification

Distortion

Film Density:

It is the amount of incident light that passes through a radiograph. It represents the degree of darkness of an exposed film (after processing). White areas (e.g., metallic restorations) have no density and black areas (e.g., air spaces) have maximum density. The areas in between these two extremes (tooth structure, bone) are represented by various shades of gray.

Factors affecting film density:

1. Milliamperage
2. Kilovoltage peak
3. Exposure time

4. Source-object distance
5. Filtration
6. Collimation
7. Subject density
8. Subject thickness
9. Patient size
10. Film processing

Exposure factors (mA, kVp, exposure time). An unnecessary increase in any of these factors results in an increase in film density.

Source-object distance: the longer the source-object distance, the lower the film density.

Filtration: The more the filtration, the lower the film density.

Collimation: The more the collimation, the lower the film density.

Patient size: the larger the patient's head, the more x-rays that are needed to produce an ideal film density.

Film processing: When the developing time or temperature increases, film density increases.

Subject thickness: film density decreases (appears lighter) when subject thickness increases.

Subject density: determined by type of material (metal, tooth structure, composite, etc.) and by amount of material.

Film density decreases (film gets lighter) when subject density increases.

In the film, the post and core in each tooth has a high object density, resulting in low film density.

Radiographic density values:

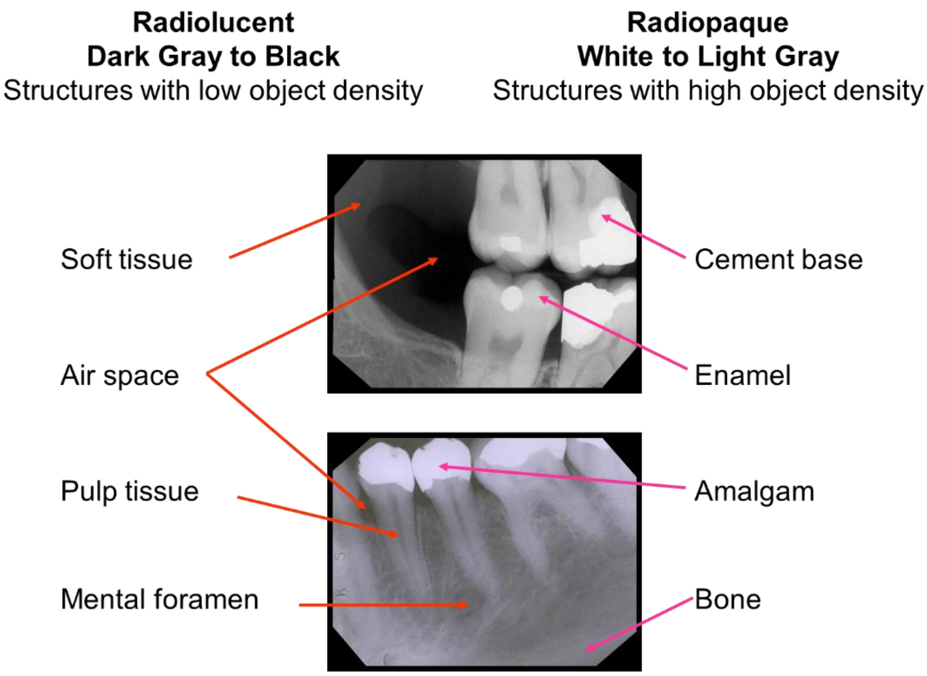
D = Log   I/T, I: quantity of incident viewing light, T: quantity of transmitted light

If the quantity of incident viewing light is considered to be 100% and if 99% of the incident viewing light is blocked or absorbed, then 1% of the incident light is transmitted.

Therefore D = Log 100/1 = 2

Radiolucent: Refers to dark areas of a radiograph (high film density); dark gray to black. Represents with little or no object density such as soft tissue, air, etc.

Radiopaque: Refers to light areas of a radiograph (low film density); light gray to white. Represents areas which have higher object density, such as gold crown, amalgam, etc.

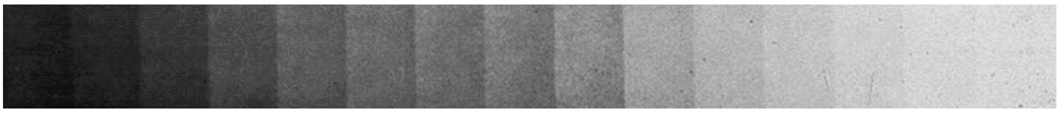


<u>Contrast:</u>

Image contrast is the difference between adjacent densities. How sharply dark and light areas are differentiated or separated on an image

The ability to distinguish between densities enables differences in anatomic tissues to be visualized. An image that has sufficient density but no differences in densities would appear as a homogenous object.

Low Contrast: With low contrast, there are many shades of gray seen on the film, with little differences among them. This is also known as long scale contrast.

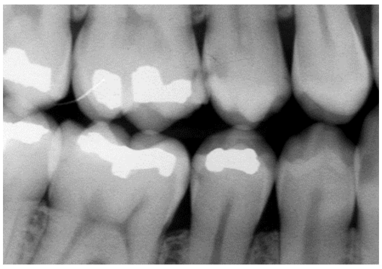


High Contrast: With high contrast, there are few densities seen on the film, with great differences among them, the predominant densities being either very light or very dark. High contrast is also known as short scale contrast.

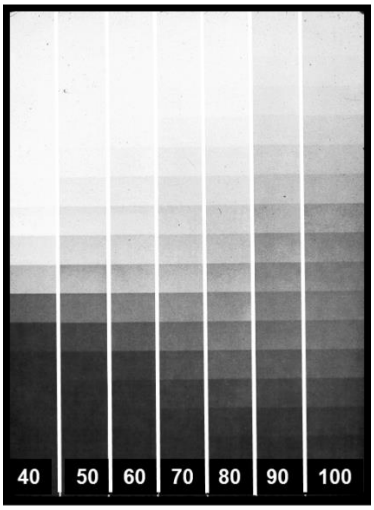
Factors affecting Contrast:

1. Subject contrast
2. Exposure factors:
   a. mAs
   b. Kilovoltage
   c. Filteration
3. Film characteristics:
   a. Film processing
   b. Film contrast
   c. Film fog
4. Scattered Radiation

Subject Contrast: In order to see an image on the film, the objects being radiographed must have different object densities. In the film below, the teeth, restorations, bone, air spaces, etc., all have different object densities, allowing us to see them on the film. The higher the subject contrast, the higher the image contrast.

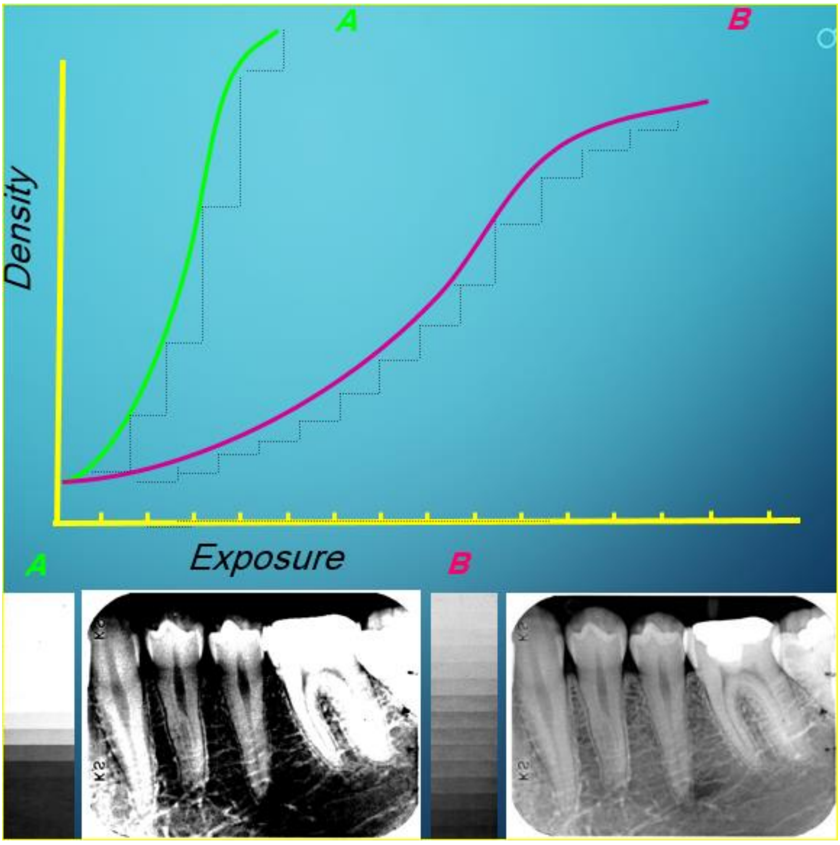


kVp: kVp controls the energy (penetrating ability) of the x-rays. The higher the kVp, the more easily the x-rays pass through objects in their path, resulting in many shades of gray (long scale contrast). At lower kVp settings, it is harder for x-rays to pass through objects with higher object densities, resulting in a higher contrast (short scale).

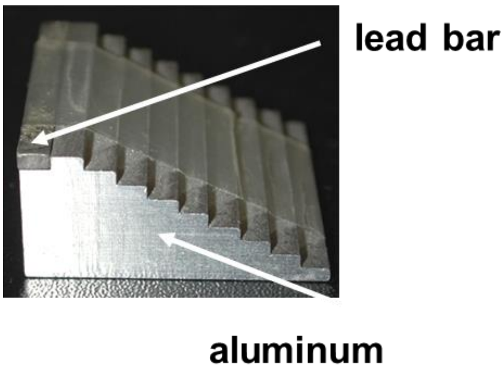


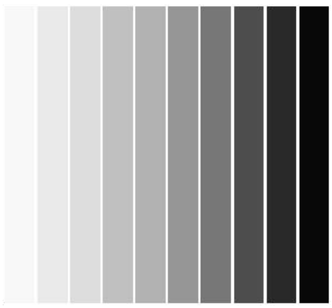
kVp settings

Film contrast: this is incorporated into the film by the manufacturer and cannot by changed by the dental radiographer. It is the capacity of the film to display differences in subject contrast.

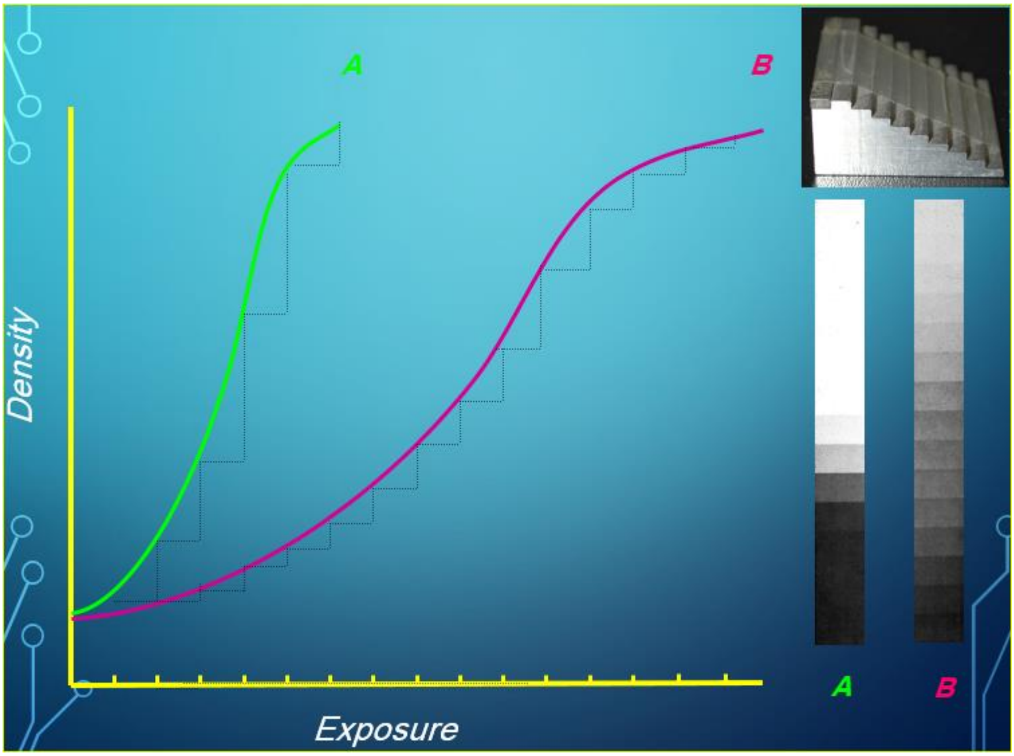


Stepwedge is a device used to demonstrate film densities and contrast scales. It can be used to demonstrate short scale and long scale contrast. When a stepwedge is placed on top of a film and exposed to X-rays, the different steps absorb varying amount of X-rays. As a result different film densities appear on a dental radiograph.





Step Wedge Pattern

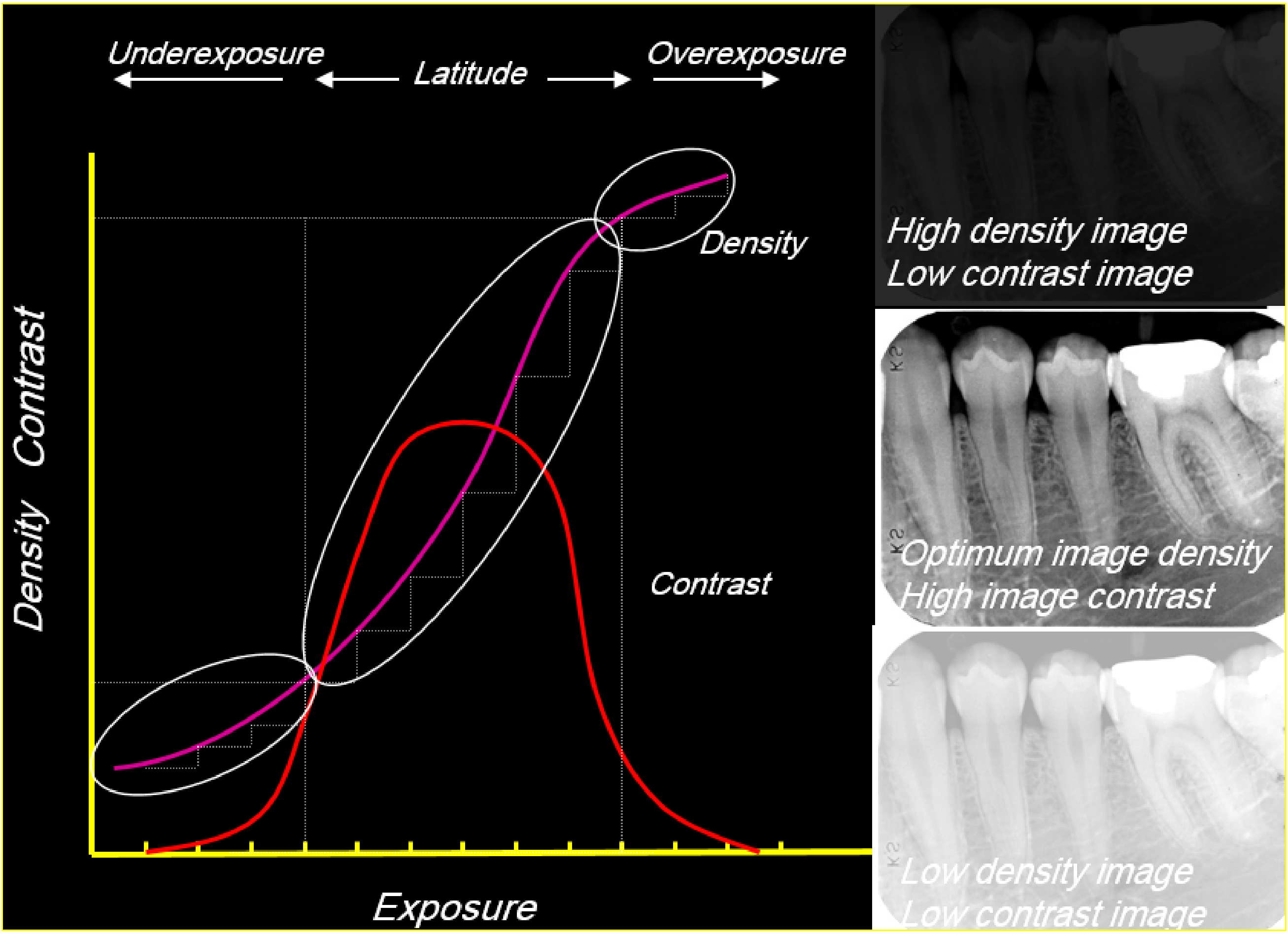


mAs: when the mAs increases, image density increases, which decreases image contrast. When mAs decreases, image density decreases, which also decreases image contrast.

High density image
Low contrast image
Long scale film contrast

Optimum image density
High image contrast
Short scale film contrast

Low density image
Low contrast image
Long scale film contrast

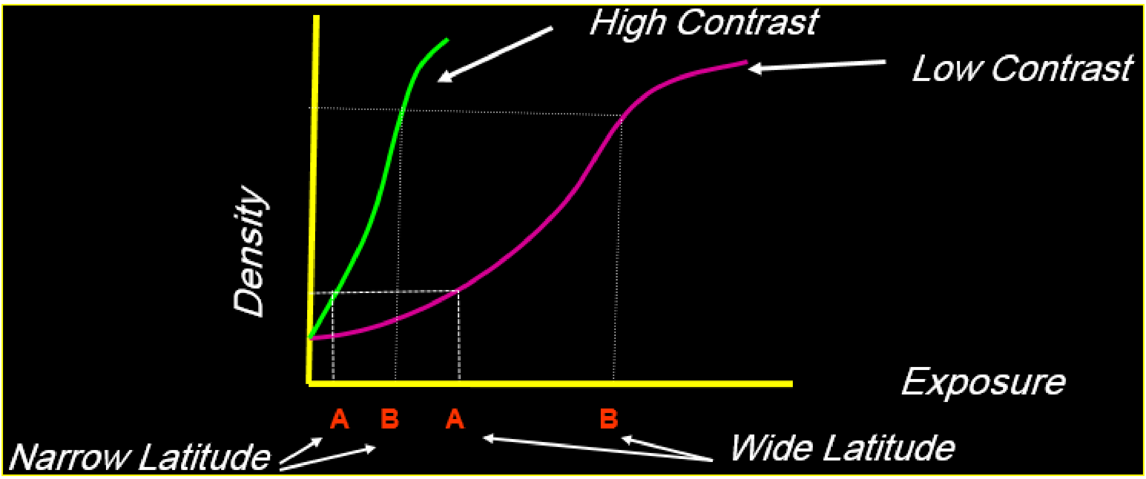


Film processing: Increasing developing time or temperature, increases image density, which decreases contrast

Film fog: Film fogging increases image density, which decreases image contrast.

Scattered Radiation: Scattered radiation causes film fogging, which increases overall image density, which decreases image contrast.

Film Latitude:



The latitude of a film represents the range of exposures that will produce diagnostically acceptable densities on a film. As the latitude of a film increases, the contrast of the film decreases. In general, high film contrast (green curve) requires very precise exposure of the film; if it is too high or too low, the film will be too dark or too light, resulting in a non-diagnostic film. With low film contrast (purple curve) the film will be diagnostic over a broader range of film exposure.

Background fog density Gross fog – Base plus fog:

This is a small degree of blackening evident even with zero exposure.

It is due to:

- The color/density of the film base.
- The development of some unexposed silver halide crystals.

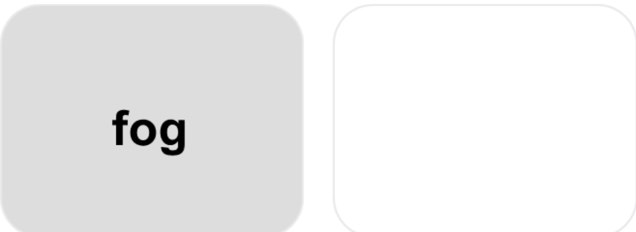
Background fog density should be less than 0.2.

Film fog:

This is an increased film density resulting from causes other than exposure to the primary x-ray beam.

Causes of fog:

1. Unsafe light (light leak, improper safelight).
2. Scatter radiation.
3. Improper film storage.
4. Expired film.
5. Prolonged development.
6. Contaminated developer.



Film fog makes the whole film darker, making it harder to see the density differences (decreased contrast).

Film speed:

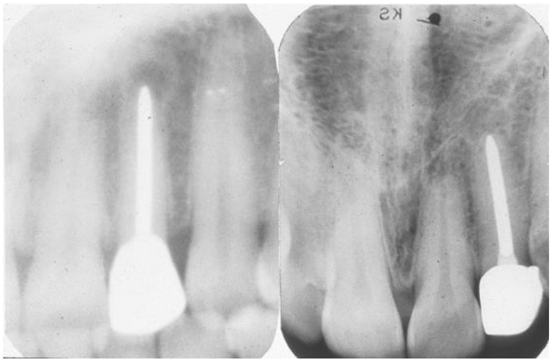
This is the exposure required to produce an optical density of 1.0 above background fog density. The higher the speed, the less the exposure required for a given film density and the lower the radiation dose to the patient.

The larger the crystals, the faster the film, but the poorer the image sharpness.

<u>Sharpness (Definition):</u>

The sharpness of an image is a measure of how well the details (boundaries/edges) of an object are reproduced on a radiograph (refers to the capability of the receptor to reproduce the distinct outlines of an object, influenced by focal spot size, film composition, and movement).

The sharpness of an image is dependent on the size of the penumbra.

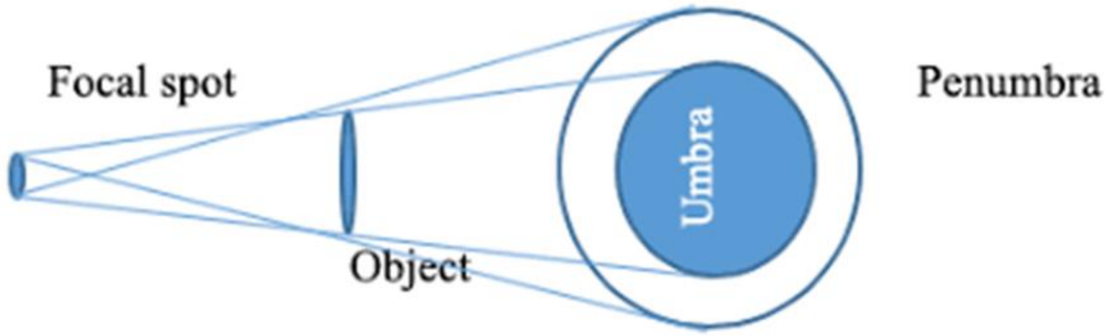


Penumbra:

The area on the film that represents the image of a tooth is called the umbra, or complete shadow.

The area around the umbra is called the penumbra or partial shadow.

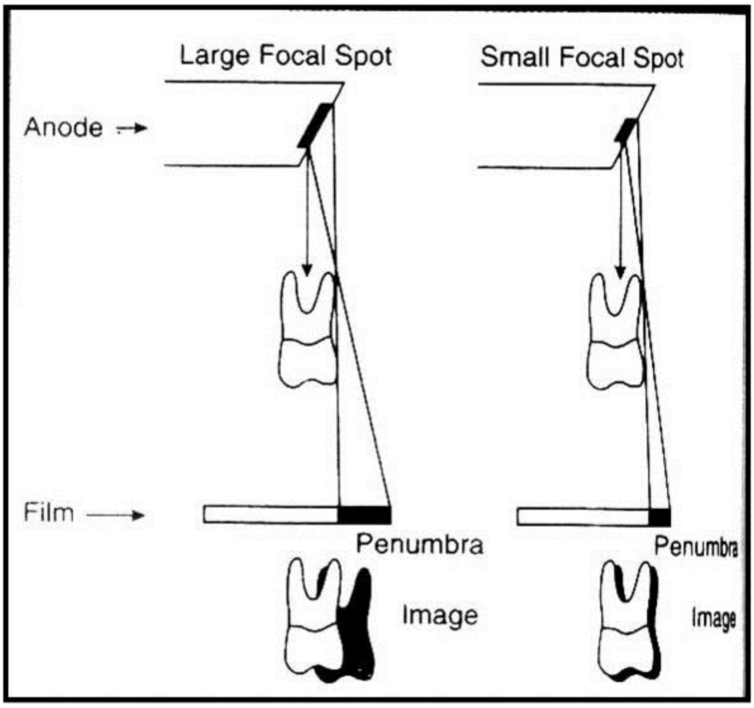
The penumbra is the zone of unsharpness along the edge of the image; the larger it is, the less sharp the image will be.



Factors affecting Sharpness:

1. Focal spot size.
2. Film composition.
3. Patient movement.
4. Source-object distance.
5. Object-film distance.

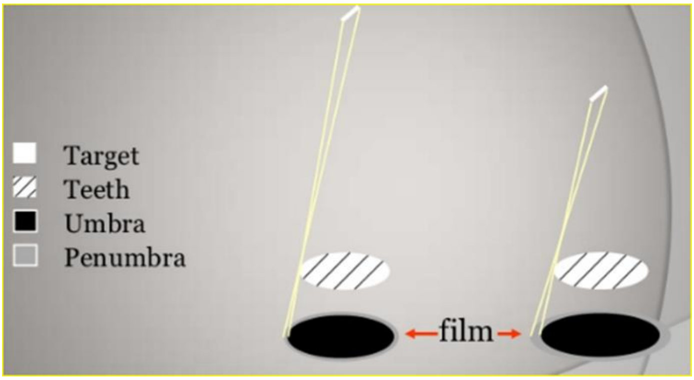
***Decreasing focal spot size, increases sharpness*:**



Film Composition:

The larger the crystal size, the less the sharpness. Slow films with small crystal sizes produce sharper images than fast films with larger crystals sizes.

Increasing source-object distance, increases sharpness:

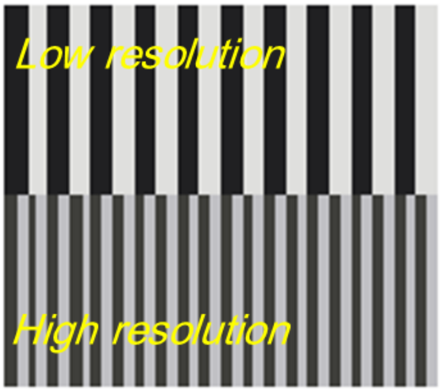


Methods for minimizing loss of image clarity and improving image quality (improving image sharpness):

1. Using a small effective focal spot size.
2. Using a slower speed film (film composition).
3. Avoid patient movement.
4. Increasing Source-object distance.
5. Decreasing Object-film distance.

Resolution:

It is the ability to distinguish between different structures that are close together. Resolution is expressed in terms of line pairs per millimeter (Lp/mm). In the space of 1 mm, the number of line pairs that could be distinguished determines the amount of resolution. Each line pair is made up of a line and a space. Human eye is able to discern 5 Lp/mm. Resolution depends on film composition: the larger the crystal size, the less the resolution. Slow films with small crystal sizes produce higher resolution images than fast films with larger crystals sizes.



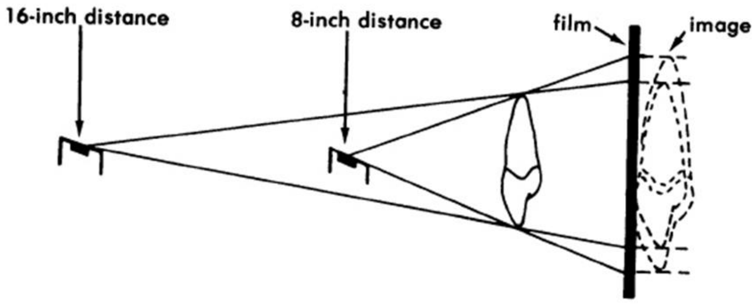
Magnification:

Magnification is the increase in the size of an object. It is caused by the divergence (spreading out) of the x-ray beam as it moves away from the target.

Factors affecting Magnification:

1. Object–film distance.
2. Source–film or Source-Object distance.

Increasing source-object distance, decreases magnification:



Decreasing object-film distance, decreases magnification:

Calculating magnification:

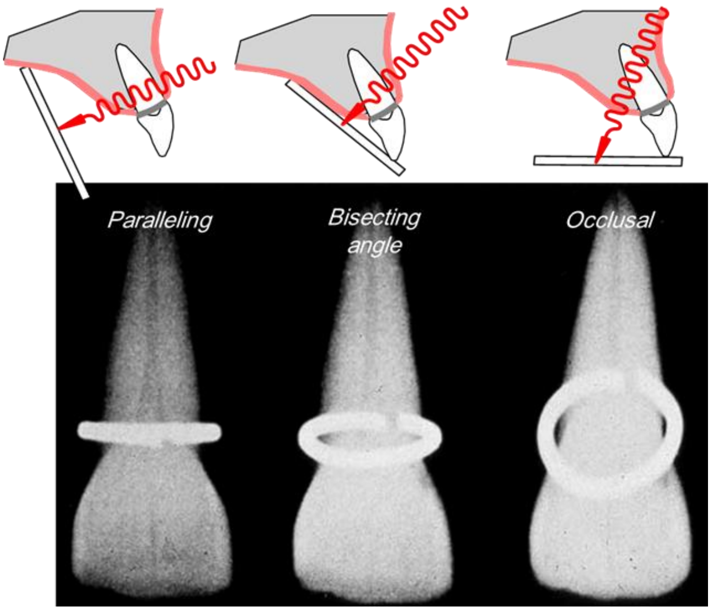
Object size = <u>Source – object distance</u> x <u>Image length</u> / <u>Source – film distance</u>

What is the true size of a tooth when the source – film distance is 16 inches, the source – object distance is 15 inches and the tooth image length on the radiograph is 28 mm?

Object size = 15 x 28 / 16 = 26.25 mm

<u>**Distortion**:</u>

Distortion is the variation in the true size and shape of the object being radiographed



Factors affecting Distortion:

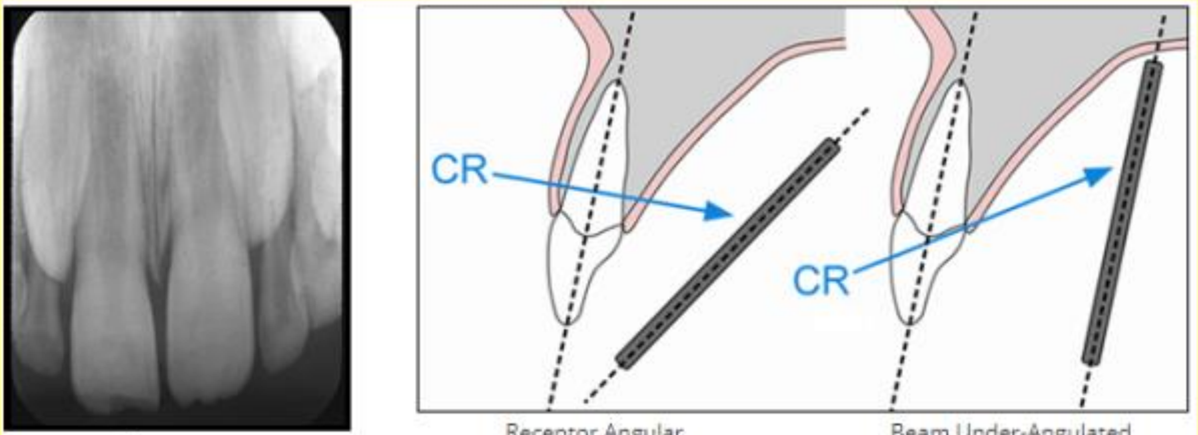
1. The object-film alignment (angle between the film and teeth).
2. The x-ray beam alignment (the angle the x-ray beam forms with both the film and the teeth).

To minimize distortion:

The object and film must be parallel to each other

The X-ray beam must be directed perpendicular to the tooth and the film.

Elongation:

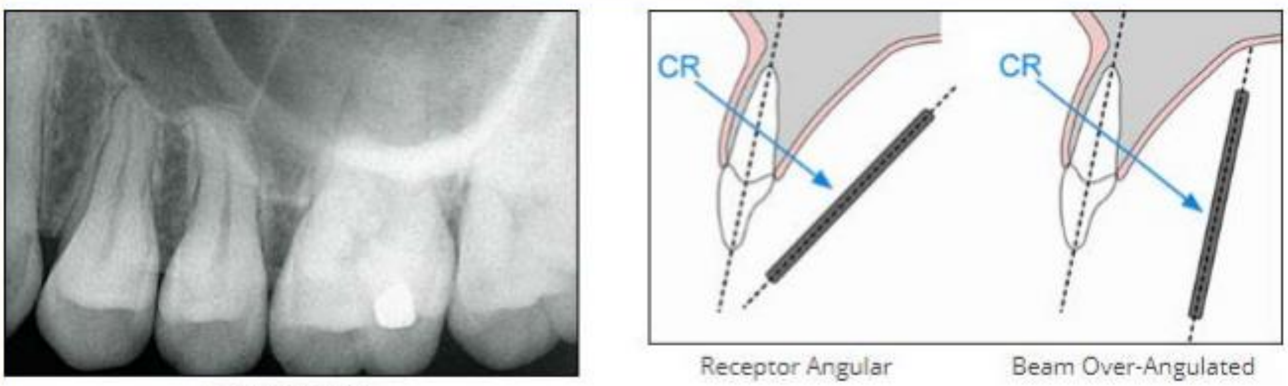


Elongation

Receptor Angular

Beam Under-Angulated

Foreshortening:



Foreshortened

Receptor Angular

Beam Over-Angulated

Five rules for accurate image formation:

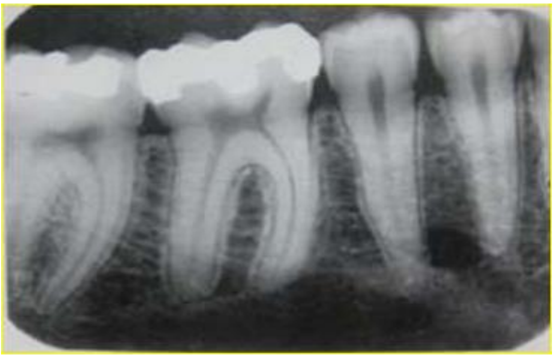
1. The radiation source should be as small as possible.
2. The source-tooth distance should be large.
3. The tooth-film distance should be small.
4. The tooth and film should be parallel.
5. The x-ray beam should be perpendicular to tooth/film.

Diagnostic image: Image that has proper density and contrast, sharp outlines, and is the same shape and size as the object.

Ideal Radiograph:

In the ideal radiograph, the image is the same size as the object, has the same shape and has a sharp outline with good density and contrast. Because the receptor must always be at some distance from the object, with bone and soft tissue in between, the object will always be magnified to some degree. Though magnified, the image of the object will usually have the same shape as the object when using the paralleling technique. The sharpness, density and contrast are maximized by using a longer distance between the X-ray source and the tooth and proper exposure factors.

The mandibular molar periapical image below comes closest to satisfying the properties of an ideal radiograph (either paralleling or bisecting). The receptor is closer to the teeth in this location than in any other part of the mouth and the receptor is usually parallel with the teeth.

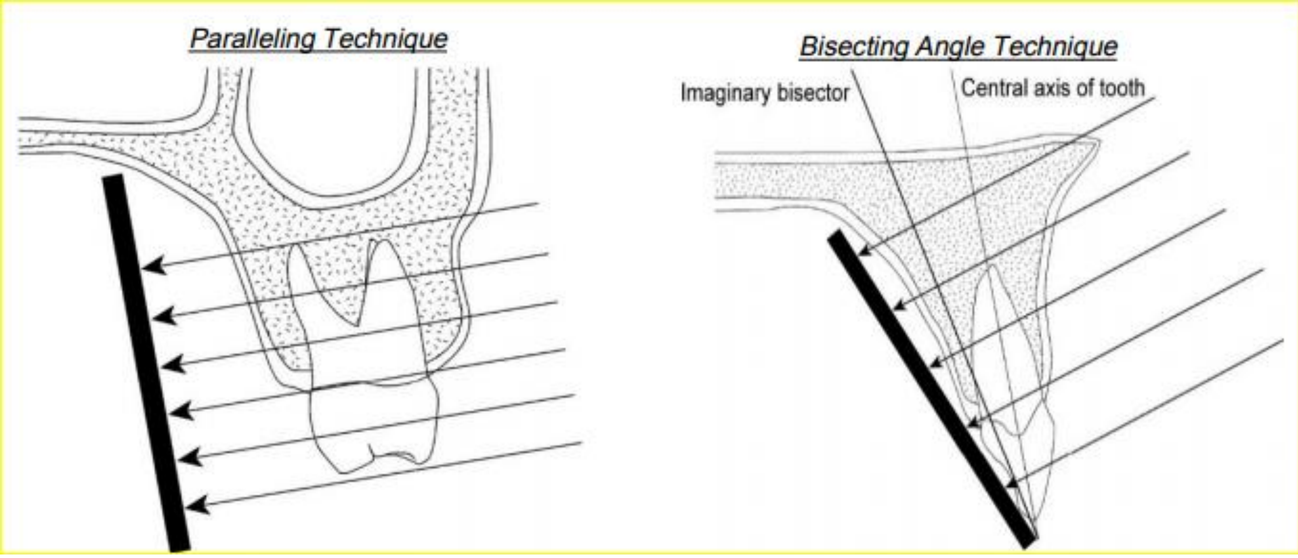


Avoiding Image Distortion:

The two most common techniques to avoid distortion are the Paralleling Technique and the Bisecting Angle Technique.

1. Paralleling Technique: The object (tooth) and image receptor are parallel to each other, and the x-ray beam is perpendicular.

2. Bisecting Angle Technique: The x-ray beam is perpendicular to the imaginary line that bisects the angle formed between the central axis of the object (tooth) and the image receptor.



Radiographic Interpretation basic:

The importance of interpretation: Radiographic interpretation is an essential part of the diagnostic process. The ability to evaluate and recognize what is revealed by a radiograph enable us to detect diseases, lesions and conditions which can't be identified clinically.

Interpretation Vs. Diagnosis: Interpretation refers to an explanation of what is viewed on a radiograph while diagnosis refers to the identification of disease by examination or analysis. In other words the interpretation is a step in the diagnosis.

Rules of radiographic interpretation:

1. The area to be examined must be completely shown at optimal angulations.
2. All the boundaries of the area of interest must be shown with normal structures around it.
3. Knowing and familiarity with all normal anatomical landmarks as well as all various pathological conditions that may affect the area of interest.
4. Optimum viewing condition.

Viewing condition: Ideally, should include the following:

- Ambient light in the room should be reduced.
- Intraoral radiographs should be mounted.

– Light from the view-box should be of equal intensity across the viewing surface.
– The size of the view-box should accommodate the size of the film.
– A magnifying lens allows detailed examination of small regions of the film.

Image Analysis:

The first step in image analysis is to use a systemic approach to identify all the normal anatomy present in an image.

Avoid limiting your attention to one particular region of the film.

Steps of interpretation:

– Localization.
– Observation.
– General consideration.
– Interpretation.
– Correlation.

Localization:

– Localized or generalized.
– Position in the jaw.
– Single or multiple.
– Size.

How to identify the position of the periapical film? Embossed dot identify right from left and the anatomical land mark to identify the jaw and the area.

Upper left

Lower left

(Right, Left) Periapical radiographs of maxillary anterior teeth after treatment (black arrows show resorption of the apical root tips).

Upper right premolar

Upper left premolar

Observation:

All shadows, other than the localized shadows of the normal landmarks must be observed.

For example: shadows in crowns, cervical area, roots, restorations, size of root canals, periodontal membrane space, periapical area, alveolar crest, foreign bodies, integrity of bone ………….

General consideration:

A radiograph shows only 2 dimensions of a 3 dimensional object (width and height but not the depth).

Cervical burnout: usually appears as cervical RL and misinterpreted by caries; this occurs due to less density and more penetration of rays.

Pulp exposure never to be determined from radiograph but only the proximity to the pulp.

Interpretation: Studying the features of teeth and bone:

Teeth: Study the whole tooth, (crown, root enamel, pulp….), number of teeth and finally supporting structures, (Periodontal membrane space, lamina dura, alveolar crest).

Bone: Changes in bone may include:

1- Changes in density.
2- Changes in the margin.
3- Changes inside the lesion.
4- Effect on surrounding tissues.
5- Changes in structure.

Correlation:

The final step is to correlate all of the radiographic features to reach a radiographic differential diagnosis.

Then to draw a final diagnosis, we have to correlate other data as case history, clinical examination, and other diagnostic aids with the radiographic differential diagnosis.

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