Lec 3: X- Ray Films د.هبة عزت بيرم

Radiograph: Is the image of an object made with use of X- ray instead of light.

Dental X- ray film: Is a recording media on which image of the object was made by exposing this film to X- ray.

Types of X- ray films:

1- Intra oral X- ray film
2- Extra oral X- ray film
3- Duplicating film

1- Intra oral X- ray film:

Intraoral dental x-ray film is made as a double-emulsion film (i.e., both sides of the base are coated with an emulsion). With a double layer of emulsion, less radiation is required to produce an image. Direct exposure film is used for intraoral examinations because it provides higher resolution images than screen-film combinations. Some diagnostic tasks, such as detection of incipient caries or early periapical disease, require this higher resolution.

One corner of each dental film has a small, raised dot that is used for film orientation (Fig 1). The manufacturer orients the film in the packet so that the convex side of the dot is toward the front of the packet and faces the x-ray tube. The side of the film with the depression is thus oriented toward the patient's tongue. After the film has been exposed and processed, the dot is used to orient the patient's right- and left-side images properly. When mounting radiographs, each film is oriented with the convex side of the dot toward the viewer, and on the basis of the features of the teeth and anatomic landmarks in the adjacent bone, the films are arranged in their normal sequential relationship in the mount.

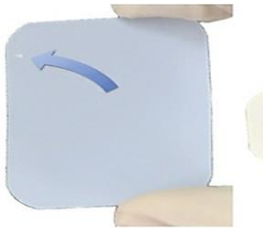

Fig 1: The raised film dot *(arrow)* indicates the tube side of the film and identifies the patient's right and left sides.

The film is encased in a protective black paper wrapper and then in an outer moisture-resistant paper or plastic wrapping. The outer wrapping protects the film from moisture, saliva and light exposure (light photon can activate the silver halides crystals). Within the film wrapper there is a **paper film wrapper**, this black paper protective sheet covers the film on either side and shields it from light exposure.



Fig 2: contents of intraoral film packet.

Lead foil is a single piece of thin lead foil present within the film packet and located behind the black paper between which the film is placed. This lead foil helps in preventing the backscattered (**secondary**) radiation from causing film fog. In addition, the lead foil absorbs X- ray that have passed through the object and the film so it reduced the exposure of the tissue behind the film. This foil has a design of (**Herring bone pattern**) or embossed pattern.

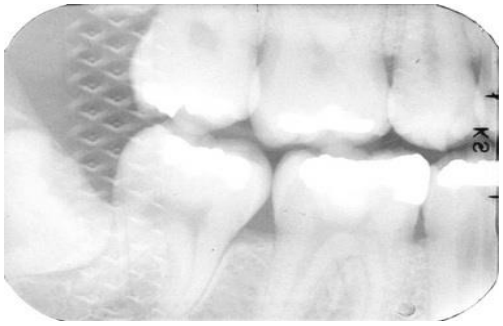

Fig 3: Placing a film backward in the patient's mouth when the exposure was made results in a radiograph that is too light and shows the characteristic markings caused by exposure through the lead foil in the film packaging.

Chemical composition of X- ray film:

X-ray film has two principal components: (1) emulsion and (2) base. The emulsion is sensitive to x-rays and visible light and records the radiographic image. The base is a plastic support onto which the emulsion is coated**.**

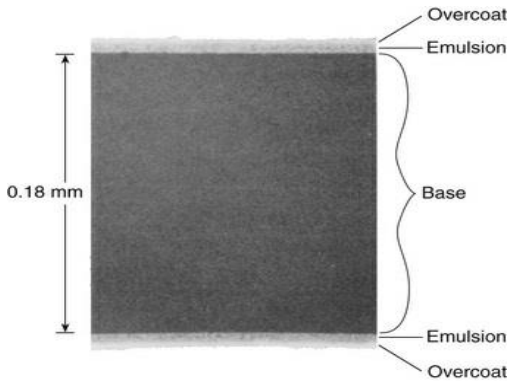

Fig 4: Scanning electron micrograph of INSIGHT dental x-ray film

1. Emulsion

The emulsion is the heart of the x-ray film, it's the material with which the x-ray or light photons interact and forming the image. The two principal components of emulsion are silver halide grains with trace amount of sulfur compounds and gold, and a vehicle gelatinous matrix in which the crystals are suspended. The emulsion is sensitive to X-rays and visible light.

- **Silver halide grains:** are composed primarily of crystals of silver bromide. Silver bromide makes up most of the silver halide grains that are incorporated in the emulsion. However, silver iodide is added in small quantities as they have crystals of larger diameter which help in increasing the sensitivity of the film.
  The silver halide crystals absorb radiation during x- ray exposure and store energy from the radiation.

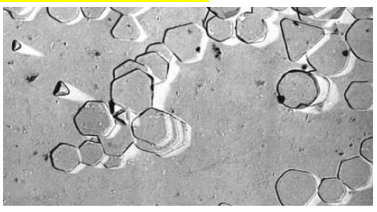

Fig 5: Scanning electron micrograph of emulsion of INSIGHT film showing flat tabular silver bromide crystals, which capture incident photons.

- **Vehicle matrix:** The silver halide grains are suspended in a surrounding **vehicle** that is applied to both sides of the supporting base. During film processing, the vehicle absorbs processing solutions, allowing the chemicals to reach and react with the silver halide grains. It is made up of gelatinous or non-gelatinous substances.

2. Base

The primary purpose of the film base is to provide a stable support for the delicate emulsion, it also provides strength to the radiographic film. The base for dental x-ray film is made of cellulose acetate measures 0.2 mm thick, which provides the proper degree of flexibility to allow easy handling of the film and uniformly translucent. The film base must also withstand heat, moisture and chemical exposure to processing solutions without becoming distorted.

3. An adhesive added to the film base before the emulsion is applied and serve to attach the emulsion to the base.

4. Protective Layer: is a thin, transparent coating placed over the emulsion as overcoat. It serves to protect the emulsion surface from manipulation as well as mechanical processing so protects the film from scratching or contamination of the film during handling or contact with the processing tanks and it also protects the film from the pressure of rollers of an automatic processor.



Fig 6: Chemical composition of X- ray film.

➢ Intraoral Film types:

A- **(Intraoral periapical films):** record the crowns, roots, and surrounding bone. Film packs come in three sizes:

- Size 0 for small children (22 mm × 35 mm)
- Size 1, which is relatively narrow and used for views of the anterior teeth (24 mm × 40 mm)
- Size 2, the standard film size used for adults (30.5 mm × 40.5 mm)

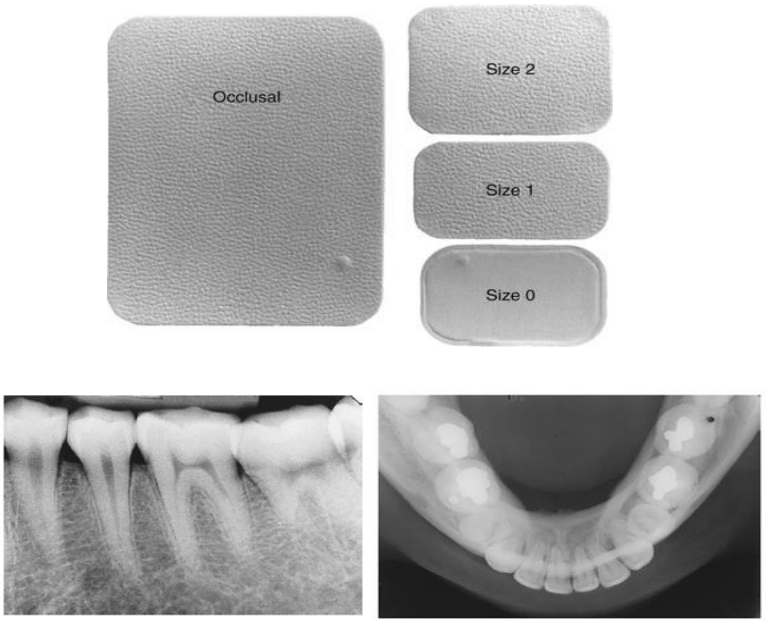

Fig 7: Dental x-ray film is commonly supplied in various sizes.

B- **(Bitewing films):** Bite-wing (interproximal) views record the coronal portions of the maxillary and mandibular teeth in one image. They are used to detect interproximal caries and evaluate the height of alveolar bone. A relatively long size 3 is also available also we can use size 2 film is normally used in adults; the smaller size 1 is preferred in children. In small children, size 0 may be used. Bite-wing films often have a paper tab projecting from the middle of the film on which the patient bites to support the film. This tab is rarely visualized on the image and does not interfere with the diagnostic quality of the image. Film-holding instruments for bite-wing projections also are available.

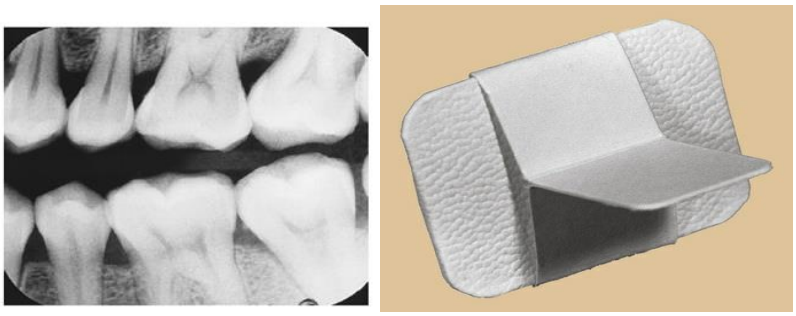

Fig 8: Paper loop placed around a size 2 adult film to support the film when the patient bites on the tab for a bite-wing projection. This projection reveals the tooth crowns and alveolar crests.

C- (Occlusal films): Occlusal film, size 4, is more than 3 times larger than size 2 film (Fig 7). It is used to show larger areas of the maxilla or mandible than may be seen on a periapical film. These films also are used to obtain right-angle views to the usual periapical view. The name

derives from the fact that the film is held in position by having the patient bite lightly on it to support it between the occlusal surfaces of the teeth.

- **Intraoral film speed:** Speed of an x-ray film refers to its sensitivity of silver bromide crystals (Ag Br) to X- ray photon. A high-speed dental X- ray film requires only less amount of radiation for the image formation, so reduces the exposure to the patient. There is direct relation between the speed of the film and the size of the crystals, the larger crystal size the faster film speed.
- Film speed, or sensitivity, is determined by the following:

  1- the size of the silver halide crystals
  2- the thickness of the emulsion
  3- the presence of special radiosensitive dyes

The classification of film speed based on **alphabetical basis so from A to F**, film speed A is the slowest while speed F is the faster one. Only films with a D or faster speed rating are appropriate for intraoral radiography. E/F-speed film is preferred because it requires approximately half the exposure time and thus half the radiation dose of D speed film. In the United States the most widely used films are ULTRA-speed (D speed) and INSIGHT (E/F speed).

2- Extra oral X- ray film:

The extra oral film is one that is placed outside the mouth during exposure. These films are used to examine larger area of the skull or jaws that cannot be seen by intra oral films such as panoramic, cephalometric and others.

Types of extra oral films:

1- Non-screen
2- Screen

1- Non-screen film: These are used without the intensifying screens.

- Film emulsion is sensitive to direct X-ray exposure rather than fluorescent light.
- Film has double emulsion like intra oral film but the emulsion is thicker.
- Increased thickness of emulsion makes the film need less amount of radiation so need less exposure time.
- The sizes include: (5×7 & 8×10 inches).

2- Screen film:

- Screen film is different from dental intraoral film. It is designed to be sensitive to ***visible light*** specially to blue light in the visible light spectrum.
- use of intensifying screens reduces the dose of x-radiation to the patient. Intensifying screens are used with films for all extraoral radiography, including panoramic, cephalometric, and skull projections. However, the use of an intensifying screen ***decreases image resolution***.
- **Size and image receptors:** Cephalometric and skull views 20×25cm (8×10 inches), Lateral oblique views 13×18cm (5×7 inches) or 15×30cm (6×12 inches).
- Screen films have 3 types: slow or detail screen, medium or par- speed screen and fast or high-speed screen.
- The screen film (emulsion) placed between 2 florescent screens in the cassette, these made from (tiny calcium tungstate crystals). When exposed to X- ray photons will create a light and this light in turn exposes the screen film to produce the image.
- These screens are placed in the film cassette, on either side of the film and are held under pressure in a rigid manner, so that the fluorescent layers of the screen and the emulsion of the film are pressed together closely. Poor contact produces a blurring of the image on the radiograph.

❖ Composition of extra oral film:

1. Cassette: Cassettes are light tight containers, which help in maintaining a uniform and intimate contact between the film and the intensifying screens.

There are 2 types:

a. **Rigid:** made of thin metal framework. The surface on the exposure side is made up of plastic and the non-exposure surface has metal clamps allow locking the cassette so as to ensure an intimate contact between the film and the intensifying screens.
b. **Flexible:** made up of flexible plastic and used for orthopantomography. These are delicate and may tear with regular use.

2.Intensifying Screens: Intensifying screens are used in pairs and are positioned on either side of a double emulsion film and it is 10 to 60 times more sensitive to x-rays than is the film alone.

Composition of intensifying screen:

I. **Base** (**polyethylene plastic,** usually 0.25 mm in thickness) and acts as a supportive material,
II. **Reflecting layer** (titanium dioxide and placed between the base and the phosphor layer. It helps in reflecting back on to the phosphor layer any light that is emitted by it),
III. **Phosphor layer** (Radiosensitive phosphor salts are incorporated into this layer of the intensifying screen),
IV. **Coat** (The coat is made up of plastic and has a thickness of 8mm. It provides protection to the underlying phosphor layer).

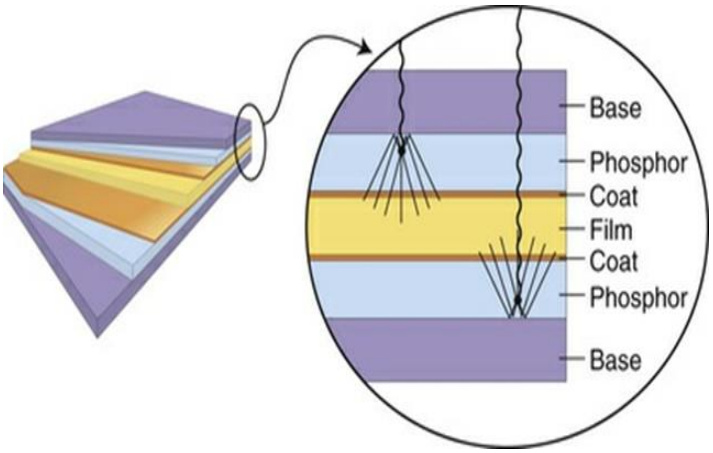

Fig 9: Image on the *left* shows a schematic of two intensifying screens enclosing a film *(yellow)*. An intensifying screen is composed of a supporting base *(purple)*, a layer containing the phosphors *(light blue)*, and a protective coat *(orange)*. The detailed view on the *right* shows x-ray photons entering at the top, traveling through the base, and striking phosphors in the base. The phosphors emit visible light, exposing the film. Some visible light photons may reflect off the reflecting layer of the base.

❖ **Types of screens:**

1- Standard blue light-emitting calcium tungsten.
2- Rare Earth green light-emitting gadolinium or lanthanum.
3- Combination double-sided.

3. Grids:

- ❖ A grid is made up of alternating strips of lead (radiopaque absorbing material) and plastic (radiolucent material) spacers.
- ❖ The use of grids increases the patient exposure by two-fold. Therefore, grids should be used only when contrast on a radiograph is really necessary. As the grid contains radiopaque absorbing materials, the exposure time has to be doubled when using a grid. If the exposure time is not changed, the resultant radiograph might show multiple thin white lines, which minimize the density of the radiograph. These lines that are seen on the radiographic image are called grid lines.

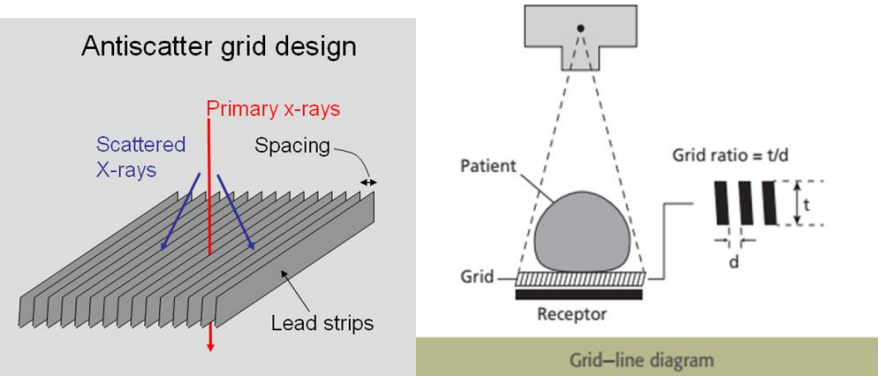

Fig 11: Grid design.

Functions

- *Grids are placed between the object to be imaged and the image receptor system (film) to preferentially minimize the amount of scattered radiation reaching the film. Grids reduce film fog from scattered radiation, thereby increasing the contrast of the resultant image.*

3- Duplicating Film

A **duplicate radiograph** is one that is identical to the original x-ray film. In dentistry, duplicate radiographs are used for patient referrals to specialists, for insurance claims, and as teaching aids. A special film, or duplicating film, is required to make a duplicate radiograph.

In dental radiography, a **duplicating film** is a type of photographic film used to make an identical copy of an intraoral or extraoral radiograph.

Unlike intraoral and extraoral films, the duplicating film is used only in a darkroom setting and is not exposed to x-rays. When examined in the darkroom under safe light conditions, duplicating film has an emulsion on one side only. The emulsion side of the film appears dull, whereas the side without the emulsion appears shiny. The emulsion side of the film must contact the radiograph during the duplication process.

➢ Procedure

Under safelight conditions, the radiographs to be duplicated are placed in close contact with the emulsion side of the duplicating film positioned so that the raised part of the mounting dot faces the light source first. When a commercial duplicating device is used, the manufacturer's recommendations should be followed, especially concerning the time of light exposure: After the light exposure is completed, the duplicating film is processed in the same manner as radiographs, by using either manual or automatic technique.

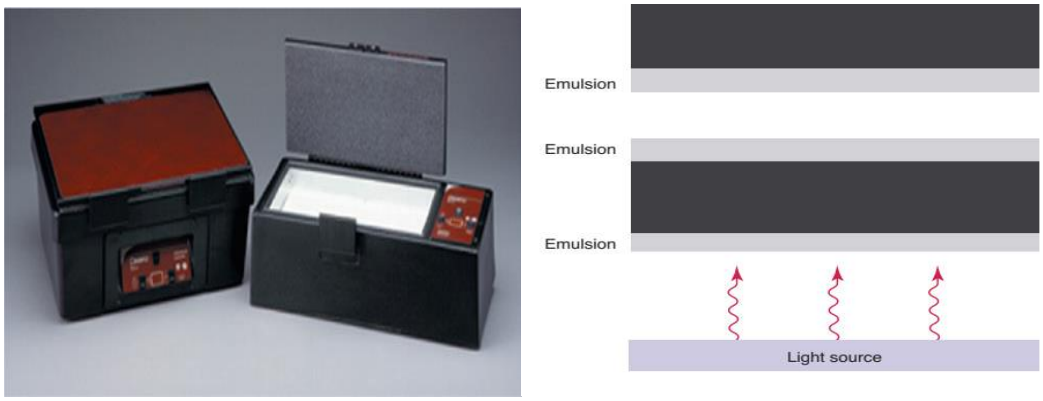

Fig12: A, Radiographic duplicator. B, Duplication. Note that the originals are placed between the light source and the emulsion side of the duplicating film.