L.7 Dental X-ray film processing

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Introduction:

Film processing refers to a series of steps that produce a visible permanent image on a dental radiograph.

Aims of Processing:

1. To convert the latent image (invisible) on the film into a visible image.
2. To preserve the visible image so that it is permanent and does not disappear from the dental radiograph.

Processing Techniques:

1. Manual processing (Sight or visual method and time-temp method).
2. Rapid processing chemicals.
3. Injectable intra-oral films.
4. Self-processing intra-oral films.
5. Automatic film processing.
6. Filmless radiographic technique (direct digital radiography).

Manual Processing:

1. Replenish solutions.
2. Check solutions levels.
3. Stir solutions.
4. Check temperature.
5. Mount films on hangers.
6. Set the timer.
7. Develop (5 minutes at 68 F, agitate for 5 seconds).
8. Rinse for 30 seconds (agitate continuously).
9. Fix for 4 minutes (agitate intermittently, 5 sec/30 secs).
10. Wash for 10 minutes in running water.
11. Dry**.**

Manual Film Processing Steps:

- Consists of following five steps:
  - Development
  - Rinsing
  - Fixing
  - Washing
  - Drying

Development:

A chemical solution developer is used in the development process. Purpose of Developer:

1. The exposed, energized silver halide crystals chemically converted into black metallic silver.
2. Softens the film emulsion during the process.

The developer reduces all the silver ions in the exposed crystals to grains of metallic silver. This process must be restricted to the exposed crystals only.

The metallic silver at the latent image site acts as a bridge by which electrons from the developing solution reach silver ions in the crystal and convert them to metallic silver.

Individual crystals are developed completely or not at all. Variations in density on the processed radiograph are the result of different ratios of developed and undeveloped crystals.

The crystals that do not have exposure centers are not affected by the developer if films are in the developer for the correct amount of time and the temperature of the developer is correct.

However, if the films are left in the developer too long, or the temperature is too high, the developer will start to act on the crystals that were not exposed by x-rays (no exposure centers) and these crystals will also be converted to black metallic silver. This results in the film being darker than ideal (Chemical fog).

Rinsing:

Films should be rinsed in water for 30 seconds with continuous gentle agitation is necessary after developing before they are placed in the fixer:

1. It dilutes the developer and slowing the development process.

2. It also removes the alkaline activators to prevent neutralization and contamination of the acidic fixer.

Not used with automatic processing.

Fixing:

A chemical solution fixer is used in the fixing process.

Purpose of Fixer:

1. Remove the unexposed, unenergized silver halide crystals from the film emulsion.
2. Hardens the film emulsion during the process.

Washing:

Necessary to thoroughly remove all the excess chemicals from the emulsion. The film is washed in a sufficient flow of water from 15 to 20 minutes.

To remove all Thiosulfate ions and Silver Thiosulfate complexes. Any Silver compounds or Thiosulfate that remains because of improper washing causes yellowish brown stains which are most apparent in the radiopaque areas. This discoloration results from the Thiosulfate reacting with Silver to form brown Silver Sulphide.

Drying:

After the films have been washed, surface moisture is removed by gently shaking excess water from the films and hanger. The films are dried in circulating moderately warm air

If the films are dried rapidly with small drops of water clinging to their surface, the areas under the drops dry more slowly than the surrounding areas. This uneven drying causes distortion of the gelatin, leaving a drying artifact.

Excessive heat must be avoided as it may damage the emulsion. Drying air should be filtered and free of dust and lint, since these particles may stick to the wet film as it dries and produce undesirable artifacts. Drying can be done using an electric fan or cabinet driers.

Should be air dried at room temperature in a dust free area. Must be completely dried before they can be handled for mounting and viewing.

Processing Room Requirements:

Darkroom:

- At least 4 x 5 feet.
- Light proof.
- Well ventilated.
- Safe lighting.
- White illumination.

A well planned dark room makes the processing easier, which should be of at least 4 × 5 feet (1.2 × 1.5 m).

Characteristics of darkroom:

1. Convenient location and adequate size.
2. Ample working space with adequate storage.
3. Lighting.
4. Temperature and humidity controlled.
5. Darkroom plumbing.
6. Miscellaneous.

Location:

Darkroom should be located near the area where the x-ray units are installed. Darkroom size is determined by the following factors:

1. Volume of radiographs processed and number of persons using the room.
2. Working Space: Adequate counter area where films can be unwrapped. A clean, organized work area is essential which should be free of processing chemicals, water, dust, and debris.
3. Storage Space: Adequate space for storage for chemical processing solutions, film cassettes etc.
4. Lighting: The room must be completely dark and must exclude all visible light. Any leaks of white light in the darkroom causes film fog.

Two types of lighting are essential in darkroom. Room lighting (white illumination) and Safe lighting. Room lighting: Incandescent room lighting is required to perform task such as cleaning, stocking materials and mixing chemicals, this is not associated with the act of processing films. Safe lighting Special kind of lighting of relatively long wavelength and low intensity illumination that does not rapidly affect open film but permits one to see well enough to work in the area. To minimize the fogging effect of prolonged exposure, the safe light should have a 15 W bulb and a safe light filter

(red GBX-2 filter). It should be mounted at least 4 feet (1.2 meters) above the surface where films are handled.

Temperature and Humidity: Should be controlled to prevent film damage. Room temp of 70 degree F is recommended; if exceeds 90 degree film fog results. Humidity level of between 50 and 70 percent should be maintained; when too high, film emulsion does not dry; when too low, static electricity becomes a problem and causes film artifacts.

Darkroom Plumbing: Must include both hot and cold running water along with mixing valves to adjust the water temperature in the processing tanks with utility sink. **Miscellaneous Requirements:** i) Wastebasket for disposal of all film wrappings. ii) X-ray view box used to examine radiographs.

Equipment Requirements: Manual Processing tanks, Timer, Thermometer, Film hangers, and miscellaneous equipment.

Manual Processing Tank: Has 2 insert tanks and 1 master tank. Constructed of stainless steel -Does not react with processing solutions and easy to clean. Practical size for a master tank in dental office is about 20 × 25 cm.

Insert Tanks: 2 removable 1-gallon (3.8 L) insert tanks hold the developer and fixer solutions, placed in master tank. Developer solution is placed on the left and fixer solution placed on right in the master tank. Water in master tank separates the two insert tanks. **Master Tank:** Filled with circulating water. An overflow pipe is used to control the water level in the master tank.

Timer: A timer is use to signal the radiographer that the films must be removed from the current processing solution. Development time depends on the temperature of the developer solution.

Thermometer: Use to determine the temperature of developer solution; optimum temp is 68 degree F, below 60 degree F chemical works too slowly, results in under development; above 80 F chemical works too rapidly, will cause film fog. Floating thermometer or one that is clipped to the side of the developer tank may be used. Temperature of developer sol, determine the development time.

Film Hangers: Also known as processing hangers. Device equipped with clips used to hold films during processing. Made up of stainless steel. Available in various sizes and can hold up to 20 intraoral films. **Miscellaneous Equipments:** i) Stirring rods-made up of plastic or glass use to stir the developer and fixer solutions, and equalizes the

temperature of the solutions. ii) Plastic apron-use to protect clothing during the processing of films and mixing of chemicals.

Manual Processing Procedure:

The film is placed in the developer for a specific time (5 min. at 68 degrees) with the lid in place to keep out light. The developer turns the silver halide crystals into black metallic silver.

After the proper time in the developer, the lid is removed and the film hanger is placed in the water bath to rinse off the developer (agitate for 30 seconds). The films are then placed in the fixing solution. (Agitate for 5 seconds every 30 seconds).

After the proper time in the fixer (4 minutes), the film hanger is placed in the water bath (10 minutes) to wash off any remaining solutions. The films are then hung to dry.

Processing films at temperatures higher or lower than recommended or for longer or shorter times than recommended result in decreased film contrast.

Thermometer should contain alcohol not mercury because they could break and contaminate the processor solutions.

Temperature	**Development time**
68 F	5 min
70 F	4.5 min
72 F	4 min
76 F	3 min
80 F	2.5 min

Changing solutions:

Exhaustion of the developer results from:

1. Oxidation of the developing agent.
2. Depletion of hydroquinone.
3. Buildup of bromide.

- Exhausted developer results in films with low density and contrast.
- When fixer becomes exhausted, silver thiosulfate complexes form and halide ions build up.

- Increased concentration of silver thiosulfate complexes decreases the rate of diffusion of these complexes out of the emulsion.
- The halide ions slow the rate of clearing of unexposed crystals.
- Exhausted fixer results in incompletely cleared films that turn brown with age.

When to change the processing solutions?

A double film packet is exposed for the first patient radiographed after new solutions have been prepared.

One film is placed in the patient's chart and the other is mounted on a view box in the darkroom.

As successive films are processed they are compared with this reference film.

Loss of image contrast and density becomes evident as the solutions deteriorate indicating when the time has come to change them.

Rapid processing chemicals:

- Advantageous in endodontics and emergency.
    - More concentrated solutions.
    - Develop film in 15 sec.
    - Fix film in 15 sec.
    - At room temp.
- Doesn't have the same degree of contrast as conventionally processed film.
- They discolor over time.
- Conventional solutions are preferred for routine use.
- To improve the contrast and keep them stable in storage, rapidly processed films are placed in conventional fixing solution for 4 minutes and washed for 10 min after viewing.

Automatic Film Processing:

Advantages:

- Time saving (takes 4 to 6 minutes to process a film).
- Doesn't require a dark room because it has a daylight loader.
- Consistent density and contrast.

In order to process the films rapidly:

- The chemical composition of the developer and fixer are modified to operate at higher temperatures than those used for manual processing.
- Higher concentration solutions are used.
- Regular automatic replenishment system is used.
- Rinsing step is eliminated.

The fixer has an additional hardener to help the emulsion withstand the transport system.

Disadvantages:

1. Expensive.
2. Needs regular maintenance.
3. Must process a certain number of films per day, otherwise it will not perform efficiently.
4. High temperature tends to produce chemical fog and rapidly deteriorates the strength of the solutions+.

Automatic Processor Rollers:

1. Transport the film through the developing solutions.
2. Their motion keep the solutions agitated which results in uniform processing.
3. They press on the emulsion, forcing some solution out of it and the emulsion rapidly fills again with solution thus promoting solution exchange.
4. Rollers at the crossover point between the developer and fixer minimize the carryover of developer into the fixer tank which maintains the uniformity of the processing chemicals.

Self-processing Intra-oral films:

Self-developing films are an alternative. The x-ray film is presented in a special sachet, containing developer and fixer. Following exposure the developer tab is pulled, unveiling developer solution, which is milked down towards the film and massaged around it gently. After about 15 seconds, the fixer tab is pulled to release fixer solution, which is similarly milked down to the film. After fixing the used chemicals are discarded and the film is rinsed thoroughly under running water about 10 minutes.

Advantages:

1. No darkroom is needed.
2. Time saving.

Disadvantages:

1. Poor image quality.
2. Image deteriorates rapidly with time.
3. No lead foil inside film packet.
4. Film packet is very flexible and easily bent.
5. Difficult to use with film holders.
6. Expensive.

A rigid plastic backing was manufactured to help reduce the problems of flexibility and lack of lead foil.

Direct Digital Radiography:

Advantages:

1. Lower radiation dose is required.
2. Computer manipulation of the image.
3. Automated image analysis.
4. No need for conventional processing, thus avoiding all processing film faults and the hazards associated with handling the chemical solutions.
5. Storage and archiving of patient information.
6. Teleradiology (transference of images between institutions).

Disadvantages:

1. Expensive.
2. In Direct Digital systems the sensor and the computer have to be connected directly and the connecting cable can make intraoral placement of the sensor difficult.
3. Reduced resolution.
4. Image manipulation can be time consuming and misleading to the inexperienced.
5. Hard copy images may fade with time.
6. Computed or digital images are still 2 dimensional representations of 3 dimensional objects.

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