INSTITUTE OF DENTAL SCIENCES

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DEPARTMENT OF ORAL MEDICINE AND RADIOLOGY

NOTES ON

"PROCESSING OF RADIOGRAPHS"

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READER

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➢ PROCESSING OF RADIOGRAPHS

Introduction:

Even if the finest x-ray equipment is used and the most exacting radiographic technique the radiographs produced may not be of superior quality if the processing of the exposed film is correctly executed. When a beam as photons exist an object and exposes an x-ray film, it chemically changes the photosensitivity of silver halide crystals in the film emulsion. These chemically altered silver halide crystals constitute the latent image on the film. The developing process converts the latent image into a visible radiographic image.

Formation of latent image:

When a beam at photons exits an object and exposes an x-ray film, it chemically changes the photosensitive silver halide crystals in the film emulsion. These chemically altered silver bromide crystals constitute the latent image on the film. The developing process convents the latent image into the visible radiographic image.

When silver halide crystals are irradiated x-ray photons interact primarily with the bromide ions by Compton and Photoelectric interactions. In either case the immediate result is production of a fast moving electron, which has acquired its kinetic energy at the expense of the photon.

As it moves through the crystals this photo or Compton electron will gradually lose its energy by releasing other electrons, which also move through the crystal. Some if not all will pass through the sensitivity speck and are trapped. The sensitive speck thus acquires a negative change. During this process negatively changed bromide ions are converted into neutral bromine atom, which leave the crystal and are taken up by gelatin. The gelatin thus has an active and passive role in supporting the crystals.

The negative charge at the sensitivity speck will exert an electric attraction on the interstitial silver ion which are positively change and are capable of moving through the crystal. This will result in one of these ions moving to the sensitivity speck where the changes neutralize each other, the silver ion becoming a neutral silver atom.

Ag^{+} + electron $\rightarrow$ Ag

This single atom of silver then acts as an electron trap for a second electron. The negative charge causes a second silver ion to migrate to the trap to form a two atom silver nuclei. Growth of silver atom at the site of original sensitivity speck continues by repeated trapping of electrons followed by their neutralization with interstitial silver ions.

A single silver halide crystal may have one or many of these centers in which the atomic silver atoms are concentrated. These small clumps of silver though not seen by naked eye can be seen through electron microscopy. These clumps of silver atoms are termed latent image centers and are the site at which the developing process will cause visible amounts of metallic silver to be deposited. The difference between an emulsion grain that will react with the developing solution and thus become a visible silver deposit and a grain that will not be "developed" is the presence of one or more latent image centers in the exposed grain. Atleast two atoms of silver must be present at a latent image center to make a grain developable (i.e. to become a visible deposit of Ag). In practical terms the minimum number to produce develop ability is probably between three and six. The more the silver atom that exist at a latent image center, the greater the probability that the grain will be developed.

Definition :

Processing is defined "as a series of steps carried out to make the latent image visible and ensure it permanence".

Methods of processing:

A. Manual
B. Automatic
C. Day light
D. Rapid

Film processing involves the following procedure:

1. Exposed film is immersed in developing solution.
2. The film is rinsed in a running water bath.
3. Film is immersed in fixing solution.
4. Film is washed in running water bath.
5. The film is dried and mounted for viewing.

Development:

Development is a chemical process that amplifies the latent image by a factor of millions (about 100,000,000) to form a visible silver pattern. The basic reaction is reduction (addition of an electron) of the silver ion, which changes it into black metallic silver.

Ag^{+}	+	e^{-}	→	Ag.
(Silver ion in crystal containing latent image)		(Electron from developer)		(Silver atoms)

The conversion of silver bromide into silver occurs if the developing solution is able to donate electrons to the crystal. Since this result in the conversion of silver ions into silver atoms, chemicals, which are able to donate electrons, are called reducing agents and the chemical action, which they cause, is called reduction. In this case silver bromide is said to be reduced to silver.

The conversion of each silver ion is accompanied by the liberation of a bromine ion, which is first taken up by the gelatin and eventually goes into the solution in the developer.

Chemical which is suitable as a developer is the one which will easily donate electrons to latent image containing crystals but which is unable to donate electrons those not having a latent image. The exterior of the crystals is composed of negative bromine ions, with positively changed silver ions lying within this bromine barrier. Any attempt by the developer to donate an electron to the crystal will be apposed because of the electrical repulsion between the negative change lying on the outside of the crystal and the negative electrons. The developer is thus not able to reduce this crystal of silver bromide to silver.

A silver bromide crystal, which contains a latent image, has a congregation of silver atoms at the surface of the crystal and this constitutes a break in the barrier. At this point electrons from the developer are able to penetrate into the crystal and effect the reduction of the silver ions. This process will continue until all the silver ions have been converted to silver and all the bromine ions have passed into solution in the developer.

Individual crystals are developed completely or not at all during the recommended developing times. Variations in density on the processed radiographs are the result of different ratios of developed (exposed) and undeveloped (unexposed) crystals. Areas with many exposed crystals are denser (blacker) because of their higher concentration of black metallic silver granules after development. If the developer remains too long in contact with AgBr halide crystals that don't contain a latent image, it slowly reduces and thereby overdevelops the image.

When an exposed film is developed, the developer initially has no visible effect. After this initial phase, the density increases, very rapidly at first and then slowly. Eventually all the exposed crystals develop (become reduced to black metallic silver), and the developing agents starts to reduce the unexposed crystals. The development of unexposed crystals results in chemical fog on the film. The interval between maximal density and fogging explains why a properly exposed film doesn't become overdeveloped even though it may be in contact with the developer longer than the recommended interval. Thus dark films usually are the result of overexposure rather than over development. An overexposed films develops larger, more effective latent image sites, which explains why such a film develops acceptable density with a shorter developing time than does a film that has been properly exposed. This results in unnecessary overexposure of the patients.

The developing solution contains four components, all dissolved in water :

1. Developer
2. Activator
3. Preservative
4. Restrainer

Developer:

The primary function of the developing solution is to amplify the latent image by connecting the exposed silver halide crystals into metallic silver grains. This process being at the latent image sites.

Modern developing solution contains two developing agents.

- Hydroquinone plus
- Phenidone or metol

Hydroquinone was discovered to be a developing agent in 1880. Hydroquinone requires a strong alkali to activate it. Developers made of Hydroquinone are characterized by high contrast. Metol developers became available in 1891, and are characterized by high speed, low contrast and fine grain. Phenidone was discovered in 1940 and is similar to metol. Both metol and Phenidone are used mainly in combination with Hydroquinone.

The two agents are used because of the phenomenon of synergism, or super additivity. The mixture results in development rate greater than sum of the development rate of each developing agent. Phenidone severs as the first electron donor that converts silver ions to metallic silver at the latent image site. This electron transfer generates the oxidized form of phenidone. Hydroquinone provides an electron to reduce the oxidized phenidone back to it's original active state so it can continue to reduce silver halide grains to metallic silver.

Activator:

This is usually an alkali, which adjusts the hydrogen ion concentration (pH); which greatly affects the developing power of the developing agents, especially hydroquinone. Most radiographic developers function at a pH range of 10 to 11.5. This is achieved by the addition of sodium hydroxide. Buffers are used to maintain this condition – usually sodium carbonate sodium hydroxide, or sodium metaborate or tetraborate. The activators also cause the gelatin to swell so that the developing agents can diffuse more rapidly into the emotion and reach the suspended silver bromide crystals.

Preservative:

The developing solution contains an antioxidant or preservative, usually sodium sulfite. The oxidation products of the developing agents decompose in alkaline solution and form colored materials that can stain the emulsion. These products react rapidly with sodium sulfite to form colorless solvable sulfonates. In alkaline solution, the developing agents will react with oxygen from air. The sulphite acts as preservative by developing the rate of oxidation, especially that of hydroquinone sulfite removes oxygen from the air dissolved in the solution, or at the surface of the solution, before it has time to oxidize the developing agent. Oxidation products interfere with the developing reaction and stain the film.

Restrainer:

Fog is the development of unexposed silver halide grains that don't contain a latent image. Bromide, usually as potassium bromide, is added to the developing solution to restrain development of unexposed silver halide crystals. Although bromide depresses the reduction as both exposed and unexposed crystals, it is much more effective in depressing the reduction of unexposed crystals.

The bromide ions released by the reduction of silver ions to silver atoms pass into the developing solution. It is mainly this increase in bromide concentration that limits the life of developing solutions.

Replenishment:

During use developing solutions consume developing agents and preservative but acquire hydrogen ions and bromide. Accordingly, the developing solution of both manual and automatic developers should be replenished with fresh solution each morning. The recommended amount to be added daily is 8 ounces of fresh developer (replenishes) per gallon of developing solution. This assumes the development of an average of 30 periapical or five panoramic films per day. The purpose of this replenishment is to maintain developing agent concentration, preservative concentration, bromide concentration, and pH at a constant level, for the lifetime of the developer solution.

Almost all radiographs are now processed automatic in film processors with automatic developer replenishment. Traditional replenishment was developed for high volume operations where many films are processed each day. However, films are automatic processors operate in small installations where few film are developed each day.

The development reaction for a high volume operation.

$2\ AgBr + H_2O + Na_2\ SO_3$

(Silver bromide + hydroquinone + sod. Sulfite

↓

Development

↓

$2Ag + HBr + HOSO_3\ Na + NaBr$

(Silver + hydrobromic acid + hydroquinone monosulfonate + sodium bromide

Thus each time a film is processed, bromide and acid are formed and some developer is consumed. Thus replenishment of developer must compensate for these changes being free of bromide, by containing alkaline agents and buffers and to lesser extent, restoring depleted preservative and developing agents.

A tank of developer that sits for long periods of time with few film being processed, oxidation of the developer become more important, than the development reaction. The oxidation reaction.

$$H_2O + Na_2\,SO_3 + O_2$$

(hydroquinone + sodium sulphite + oxygen)

↓

Oxidation

↓

$$Ho\ SO_3\ Na + NaOH + Na_2\,SO_4$$

(hydroquinone monosulfonate + sodium hydroxide + sodium sulfate

Here the oxidation reaction varies the pH of the developer by forming sodium hydroxide. Also the oxidation reaction produces no bromide. Since few films are processed, replenishment is infrequent. Also since standard replenishes has a higher pH than developer and low bromide, routine replenishment will maintain the high pH and dilute bromide. Bromide concentration drops rapidly, and this has an adverse effect on film sensitometry. Develops have a lower pH and higher sulfite concentration to retard oxidation, and a high buffering capacity to minimize pH effects of oxidation. The replenisher has a lower pH than developer and contains bromide.

Rinsing:

After development the film emulsion swells becomes saturated with developer. At this point the films are rinsed in water for 30 sec. with continuous, gentle agitation before they are placed in fixer. Rinsing dilutes the developer, slowing the development process. It also removes the alkali activator, preventing neutralization of the acid fixer. This rinsing process is typical for manual processing but is not used with automatic processing.

Fixing:

Only part of silver halide in the emulsion is reduced silver during developing. The remaining silver halide impairs both the immediate usefulness and permanence of the developed radiograph. Also the presence of unexposed crystals causes film to be opaque. There fore the fixing solution must remove the unexposed silver halide without damaging image formed by metallic silver.

The function of the fixing agent is to form water solvable complexes in which silver ions are tightly bound. The solvable complex thus formed effectively removes silver ions from the solution. A second function of fixing solution is to harden and shrink the film emulsion.

Fixing solution also contains four components dissolved in water.

1. Cleaving agent
2. Acidifies
3. Preservative
4. Hardener

Cleaving agent:

Two agents form satisfactory stable complexes with silver ions, cyanides and thiosulfates. Cyanides are poisonous and are not generally used. thiosulfate in the form of the sodium or ammonium salt is the common fixing agent or “hypo”. The typical reaction include.

Silver bromide and sodium thiosulfate → Silver thiosulfate complex + sodium bromide.

The cleaving agent does not have a rapid effect on the metallic silver grains in the emulsion, but excessive fixation. Results in gradual loss of film density because the grains of silver slowly dissolve the acetic acid of the fixing solution.

Acidifier:

The fixing solution contains an acetic acid buffer system (pH4 to 4.5) to keep the fixer pH constant. The acidic pH is required to promote good diffusion of thiosulfate into emulsion and of silver thiosulfate complex out of the emulsion. The acidic fixing solution also inactivates any carry over developing agents in the film emulsion, blocking continued development of any unexposed crystals while the film is in fixing tank.

Preservative:

Sodium or ammonium sulfite is the preservative in the fixing solution. It prevents the oxidation of the thiosulfate clearing agent, which is unstable in the acidic environment of the fixing solution. It also binds with colored oxidized developer carried over into the fixing solution and effectively removes it from the solution which prevents oxidized developer from staining the film.

Hardener :

The hardening agents most often used are aluminum salts. Sometimes chromium compounds are also used. Aluminum complex with the gelating during fixing and prevents damage to the gelatin during subsequent harding. The hardeners also reduce the swelling of the emulsion during final wash. This lessens mechanical damage to the emulsion and limits water absorption, thus shortening drying time.

WASHING

After developing and fixing, the film is washed in a sufficient flow of water for an adequate time to ensure removal of all thiosulfate ions and silver thiosulfate complexes. Washing efficiency declines rapidly when the water temperature falls below 60^0F. Any silver compound or thiosulfate that remains because of improper washing discolors and causes stains, which are more apparent in the radiopaque (light) areas. This discoloration results from thiosulfate reacting with silver to form brown silver sulfide, which can obscure diagnostic information.

DARK ROOM

The primary function of dark room is to provide a completely darkened environment where x-ray film can be handled and processed to produce diagnostic radiographs.

Room requirements :

A well-planned darkroom makes processing easy. The ideal darkroom is result of carefully planning and it must be

- Conveniently located
- Adequate size.
- Equipment with correct lighting
- Arranged with ample work space
- Arranged with adequate storage
- Temperature and humidity controlled

Location and size :

The location should be convenient and should be near to area where x-ray units are installed. It must be large enough to accommodate film processing equipment and at the same time ample working space. It should be at least 4 x 5 feet (1.2 x 1.5m) i.e 16-20 square feet area, practically providing enough space for one person to work comfortably. The size of dark room is determined by various factors.

1. The volume of radiographs being processed.
2. The number of persons using the room.
3. The type of processing equipment.
4. Space required for duplication and film storage.

Lighting :

The room must be completely dark and must exclude all visible light. The term light tight is often used to describe the darkroom. In a darkroom when all the lights are turned off, no white light should be seen. Any white light coming around the door, the vent of the key hole and through wall or ceiling seen is known as light leak and must be corrected. Any leaks of white light in the darkroom causes film fog. A fog film appears dull gray, lacks contrast and is non-diagnostic. Two types of lighting are essential in darkroom.

- Room lighting (white illumination) and
- Safe lighting.

Room lighting :

Incandescent room lighting is required for procedures not associated with the act of processing films.

An over head white light that provides adequate illumination for the size of the room is necessary to perform task such as cleaning, stocking materials and mixing chemicals.

Safe lighting :

This is a special kind of lighting. It is a low intensity illumination of relatively long wave length (red spectrum) that does not rapidly affect open film but permits one to see well enough to work in the area. It is best to place safe light above the work area on the wall behind the processing thanks and somewhat to the right of the fixing tank. To minimize the fogging effect of prolonged exposure, the safe light should have a 15 bulb and a safe light filter. It should be mounted atleast 5 feet (1.2 metes) above the surface where films are handled.

X-ray films are very sensitive to the blue green region of spectrum and less sensitive to yellow and red wavelengths. Accordingly, the red GBX-2 filter is recommended as a safelight in darkroom. Where either intraoral or extraoral films are handled. Film handling under a safe light should be limited to about 5 minutes because film emulsion shows some sensitivity to light form a safe light with prolonged exposure. The older ML-2 filters (yellow light) are not appropriate for fast intraoral dental films or extraoral panoramic of cephalometric film.

Safe light should provide 3 zones of illumination

1. Dimly lit zone – for opening and loading film.
2. Medium illumination zone-for developing and fixing.
3. Brightly lit zone – for washing and drying.

Processing tanks :

All dental offices must have the capability to develop radiographs by tank processing. The tank must have hot and cold running water and a means of maintaining the temperature between 60^0 to 75^0 F. A practical size for a dental office is a master tank about 20 x 25 cm (8 x 10 inches) that can serve as a water jacket for two removable insert that sit inside. The inset tanks usually hold 3.8 L (1 gallon) of developer or fixer and are placed with in the outer, lager mater tank. The outer tank holds the running water for maintaining the temperature of developer and the fixes in the insert tanks and for washing films. The developer customarily placed in the insert tank on the left side of the master tank and the fixer in the insert tank on the right. All the three tanks should be made up of stainless steel, which does not react with the processing solutions and is easy to clean. The master tank should have cover to reduce oxidation of the processing solutions, protect the developing film from accidental exposure to light, and minimize evaporation of the processing solutions.

Darkroom work space :

Dark room workspace must include adequate counter area, where films can be unwrapped prior to the processing. The area must be absolutely clean, dry and free of processing chemicals, water, dust and debris. If unwrapped film is contaminated the quality of radiograph is compromised. The darkroom storage space must include ample room for chemical processing solutions, film cassette and other miscellaneous radiographic supplies. Storage of the unopened boxes of films is not recommended as reaction between the fumes from chemical processing solution and the film emulsion will result in film fog.

The temperature and humidity level of the dark room must be controlled to prevent film damage. A room temperature of 70^0 F is recommended. If the room temperature exceeds 90^0 F film fog results. A relative humidity level of 50% to 70% should be maintained. When humidity levels are too low state c electricity becomes a problem and causes artifices. If humidity levels are high the film emulsion does not dry. The dark room should be well ventilated for the comfort of those working in the area and to exhaust heat from dryer and moisture from drying films.

Thermometer

The temperature of developing fixing and water solution should be closely monitored. A thermometer can be left in the water circulating though the master tank to monitor its temperature. The most devisable thermometers clip onto the side of the tank. Thermometer should contain alcohol or metal but not mercury because they could break or contaminate the processor or solutions.

Timer

The x-ray film must be exposed to the processing chemicals for specific intervals. To control the time of development and fixation, an interval timer is indispensable in the dark room.

Drying Racks

Two or three drying racks can be mounted on a convenient wall for film hangers. Drip tray is placed under teeth. The racks to catch water that may run off from the wet film. An electric fan can be used to circulate the air and speed up the drying of the film, but should not be pointed directly at the film. Also cabinet driers are available that circulate hot air around the film and accelerate drying. Excessive heat must be avoided because it may damage the emulsion. If dryers are installed in the darkroom they should be ventilated outside to dark room to pre clued high humidity and heat, which is detrimental to, unexposed films stored in the film.

Film Hangers

Also known, as film racks or processing hangers are necessary for manual processing. A film hanger is a device equipped with clips used to hold films during processing. Film hangers are made of stainless steel and include an identification tab or label. Film hangers are available in various sizes and can hold upto 20 intraoral films.

Stirring Rods

Stirring rod/paddle is necessary equipment for manual processing. A stirring rod is used to adequate developer and fixer prior to processing. It is made up of plastic or glass to avoid chemical contamination. Different paddle are used to stir developer and fixer.

MANUAL PROCESSING

Three methods

- Time temperature method.
- Modified time temperature method
- Visual method

Time temperature method:

1. Before processing check the levels of developer and fixes solution. If the solution level is low add fresh solution. Never add water to raise the level of the solution, as it dilutes the strength of chemicals.
2. Stirring the processing solution with a stirring rod or paddle. Stirring the solution mixes the chemicals and regularizes the temperature of the solution.
3. Check the temperature of the developer solution. The optimum temperature for developer is between 65^0 F to 75^0 F. If the temperature of the developer solution is outside this range circulating water tap must be regularized to adjust the tap and sufficient time must be allowed to reach the correct temperature.
4. Label the film hanger with the name of patient and date of exposure.
5. Close and lock the dark room turn off the overhead white light and turn on the safelight.
6. For intraoral film pull up and out on the colour coded tab to tear open the top of the packet.
7. Pull on the black paper tab until out about half of the packet. Fold the paper away from the film. Put the dip on the film and carefully remove the film from the packet. Dispose the entire film packet wrapping. For extraoral film, carefully remove the film form the cassette; handle all the films by edges only. Verify that each film is securely attached by running a finger on the edges of film. Reattach any loose film.

8. Based on the temperature of developer solution and the instruction of manufacture set the timer. A time temperature chart is used to determine the time interorals.

Solution temperature	Developing time	Rinsing time	Fixing time	Washing time
65^0 F (18.5^0 C)	6	0.5	10-12	20
68^0 F (20^0C)	5	0.5	10	20
70^0 F (21^0C)	4.5	0.5	9-10	20
72^0 F (22^0C)	4.0	0.5	8-9	20
75^0 F (24^0C)	3.0	0.5	6-7	20
80^0 F (26.5^0 C)	2.5	0.5	5-6	20

9. Immerse the film hangers with the films into developer solution. Film must not contact one another or the sides of the processing tanks during development.
10. Gently agitate the film hanger up and down. Several times to prevent air bubbles from dinging to the film.
11. Hang the film rack on the edge of the insert tank and make serve that all the films immersed in the developer. Activate the timer and cover the processing tank.
12. When the timer goes off, on cover the processing tank, remove the film hanger with film from the developer solution, and place it in the circulating water of the rinsing tank.
13. Agitate for 20-30 seconds. Remove and drain the excess water for several seconds.

14. Based on development time, determine the fixation time and set the timer. Fixation time is approximately double the development time.
15. Immerse the film hangers with films in fixer solution and gently agitate it up and down several time and make certain that all the films are immersed in fixer and they are agitated for 5 seconds every 30 seconds. This eliminates air bubbles and brings fresh fixer in touch with emulsion.
16. When the timer goes off uncover the processing tank and remove the films from the fixer and allow the excess fixer to drain bask into the fixer tank.
17. The films are then placed in running water for atleast 20 min. Further surface moisture is removed by gently shaking off the excess water form the film and the hanger.
18. To air dry the films suspend the film hangers with the film from the rod or during rack in a dust free area over a drip pan. If a heated drying cabinet is used the temperature should not exceed 120^0 F.
19. Remove the dry radiographs from the film hangers and use a view box to examine the radiographs and place then in an envelope labeled with patients name and date of exposure.
20. After manual processing has been completed, clean all the processing equipment that was used and clean all work surfaces. A clean dark room is essential for production of diagnostic radiographs.

Modified time temperature method :

In this method depending upon the temperature of solution, the developing time is divided on daily basis.

A table or a chart can be prepared by specifying developing time for a range of daytime temperature.

Advantage **:**

Temperature need not be maintained at particular level and at the same time consistent image quality can be gained.

Disadvantage :

For every brand of developer separate time temperature chart should be prepared.

Visual method :

In this method the exposed x-ray film is immersed in developing solution. For about 10 sec and then removed and observed in the safe light.

If adequate image have been obtained then it is put for rinsing, other wise reinserted in the developing solution till adequate image is obtained.

Disadvantage : This method is highly objective in nature and doesn't give consistent quality.

AUTOMATIC FILM PROCESSING

Automatic film processing equipment is available that automates all processing steps.

Depending upon the equipment and the temperature of operation an automatic processor requires only 4-5 min to develop six wash and dry a film.

Many dental automatic processor have a light shield (day light loading) compartment in which the operator can unwrap films and feed them into the machine without working in a darkroom.

However special care must be taken to maintain infection control when using the daylight loading compartments.

When extraoral films are processed, the light shielded compartment is moved to provide room for feeding the larger film into the processor.

Mechanism :

Automatic processors have inline arrangement. Typically this picks up the unwrapped films and passes it through the developer fixer and washing and drying sections.

The transport system most often used is a series of roller drivers by a constant special motor that operates through gears, belts and chains.

The roller often consists of independent assemblies of multiple rollers in rack with one rack for each step in the operation.

The primary function of the roller is to move the film through the processing solution but they also serve other purpose.

1) Motion also helps keep the solution agitated, which contributes to the uniformity of processing.
2) Rollers pull on the film emulsion forcing some solution out of the emulsion into the respective solutions. The emulsion on rapidly fills again other solution, thus promoting solution exchange.
3) The top rollers at the cross over point between the developer and fixer tanks move developing solution, thus minimizing carry over of developer into the fixer tank, this feature help to maintain the uniformity of processing chemicals.
4) Provides a massaging action that contributes to uniform distribution of chemical on film.

The chemicals composition of the developer and fixer are modified to operate at higher temperature than those used for manual processing and to meet more rapid developing, fixing, washing and drying requirements of the automatic processor.

The fixer has an additional hardener that helps the emulsion withstand the rigorous of the transport mechanism.

Replenishment :

As the activity of the developing and fixing solution lessens its effect on the film diminishes.

To compensate for this loss of activity some automatic processes include an automatic replenishment system, which adds fresh developer to developer tank and fresh fixer to the fixer tank.

As with manual processing 8 ounces of fresh developer and fixer should be added per gallon of solution every day.

The water compartment holds circulating water, which is used to wash film following fixation.

After washing the wet film is transported from the water compartment to a drying chamber. The solution is replaced every 2-6 weeks according to the number of films and replenishment schedules.

The drying chamber holds warm air and is used to dry the wet films.

Advantage :

- Time saving
- Need for dark room is eliminated
- Controlled standardized processing condition. Is easy to maintain the density and contrast of the radiograph hence tends to be constant.
- Chemicals can be replenished automatically by machine.
- Large number of films can be processed continuously.

Disadvantage :

- Expensive
- Strict maintenance and regular change is required dirty rollers produce marked films.
- Some models need to be plumbed in
- Equipment is relatively expensive
- Smaller machines cannot process large extraoral films.
- May breakdown and convenient dark room equipment may be needed as back up.
- Films may get lost in the tank.

DAY LIGHT PROCESSING

Any processing method that doesn't need a dark room is called as daylight processing method. Both manual and automatic processing can be executed in this manner.

Manual day light processing involves stripping the film inside a light proof pouch within the pouch itself the stripped films are inserted in amber colored cassettes. These cassettes loaded with the film are brought outside the pouch and processing steps are carried out manually as usual but in daylight.

If an automatic processor has a daylight-loading chamber and since the entire assembly is enclosed in a light proof contains, it also can be called as daylight processing method.

Elimination of need for a darkroom is the only advantage in this method.

SELF DEVELOPING 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:

- No dark room or processing facilities are needed.
- Time saving.

Disadvantages:

- Poor over all image quality.
- Image detoriates rapidly over time.
- No lead foil inside flexible and easily bent
- These films are difficult to use in position holders.

- Relatively expensive

Rapid processing chemicals:

These solutions typically develop films in 5 seconds and fix them in 15 seconds at room temperature.

They have the same general formulation of conventional processing solution but often are more concentrated. They are especially advantageous in endodontic emergency situations.

Although the resultant image may be satisfactory they often donot achieve the same degree of contrast as the films processed conventionally and may discolor overtime. After viewing rapidly processed films, they are placed in convectional fixing solution for 4 minutes and washed for 10 mins. This improves the contrast and helps film storable.

A system of rapid processor uses a mixture of developing and fixing solution called monobath.

Special film packets containing only one x-ray film (without black paper and lead foil) are used to capture the image. In the daylight itself the monobath is injected in the film packet. The packet is gently rubbed from outside for prescribed time. The film is then removed from the packet and viewed for interpretation.

MOUNTING RADIOGRAPHS

Radiographs must be preserved and maintained the most satisfactory and useful condition. Periapical interproximal and occlusal films are best handled and stored in a film mount. The operator can handle them with greater ease and there is less chance of damaging emulsion. Mounts are made up of plastic or cardboard and may have a clear plastic window that covers and protects the film. However the window may have scratches and imperfections that interfere with radiographic interpretation. The operator can arrange several films for the same individual in a film mount in the proper anatomic relationship. This facilitates correlation of the clinical and radiological examination. Opaque mounts are best because they prevent stray light from the view box from reaching the viewers eyes.

The preferred method of positioning periapical and occlusal film in the film mount is to arrange then so that the images at teeth are in anatomic position and have the same relationship to the viewer as when the viewer faces the patient. The radiograph of the teeth in the right quadrant should be placed in the left side of the mount and those of the left side in the right side. The system advocated by ADA, allows the examiners gaze to shift from radiograph to tooth without crossing the midline. The alternative arrangement with the image of the right quadrant on left side of mount is not recommended.

IDENTIFICATION DOT

A round impression in a corner of each film, "the dot" allows rapid and proper film orientation. The manufacture orients the film in the packet so that the corner side of the dot is towards the front of the packet and faces the source of radiation. Consequently to mount the film with the images of the teeth in the anatomic position each film is first oriented with the cover side of the dot towards the viewer. Thus 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.

DUPLICATING RADIOGRAPHS

Occasionally radiographs must be duplicated. This is best accomplished by with duplicating films. The film to be duplicated is placed against the emulsion side of the duplicating film and the two films are held in position by a glass topped cassette or photographic printing frame. The films are exposed to light, which pass through the clear areas of the original radiographs and expose the duplicating films. The duplicating film is then processed in conventional x-ray processing solutions.

Unlike conventional x-ray film, duplicating films give a positive image. Thus areas exposed to light come out clear as on the original radiograph. Duplicating typically result in image with less resolution and more contrast than the original radiograph. The best images are obtained when an ultraviolet source is used.

Test for light leak:

Whether the dark room is light proof can be determined by closing the door and turning off the lights, including safe light. Light leaks if present becomes visible after 5 mins, when eyes becomes accustom to the dark. After the dark room is tested for light leaks safe light could be tested.

Safe light test:

Turn off all dark room light. Unwrap the unexposed dental x-ray film and place a coin on the film emulsion surface. Turn on the safelight for approximately the time we take to unwrap a full mouth series of film (4 mins approx) process the film.

If the outline of the coin appears, the safelight is not safe for use with that type of film or film may not be designed for use with that light and filter combination. The filter may be scratched, the wattage of bulb may be too high, the light may be too close to the area.

Developer solution:

It is most critical in processing and demands careful attention. Simple tests can be made to make sure the strength of the developer. For this two tests are available.

1. Step wedge test
2. Dental radiograph monitoring device

Step wedge test:

Make the step wedge and place it on the top of the film packet. Expose the packet using same exposure parameter as for an adult molar. Repeat this procedure ten times to create a supply of 10-exposure film packet for testing.

Process one exposed film in fresh chemical to make a reliance radiograph. Remaining nine films become control films store then in a cool dry place protected from x-ray periodically process the exposed step wedge films. Compare the densities of step wedge radiographs with the reference radiograph.

If the densities watch the developer solution is adequate. If the density is poor then the developer solution is detoriated and must be changed.

Dental radiograph normalizing and monitoring device:

This is available commercially. The device has a filmstrip with several density steps for comparing to a test film. Step by step instructions are printed on the instruction manual and it is compared with routine radiographs.

Fixer solution:

With fresh fixer solution, clearing time is 2.3 minutes. As the fixer solution looses its strength. The film takes a longer time to clear. The following is the test for clearing time.

Under darkroom condition unwrap fresh film and place it is the fixer solution. If the clearing time is over 4 minutes, the fixer should be replaced.

Automatic processing:

If automatic processor is used, check whether water-circulating system is working properly and that correct solution levels, replenishment and temperature parameters are maintained. When cleaning be careful to keep oil and grease of the rollers. Bend films tend to become stuck in the rollers. It is best to feed the film slowly and make sure they go in straight and in the right direction.

Two daily tests are useful when using automatic processor.

Begin by processing an unexposed film. The film should come out of the unit clean and dry. If it doesn't, check the solutions, safelight, or look for possible light leaks. If the film is still moist check for the dryer temperature.

Next process a film that has been exposed to light. The film should be black and dry after the processing.

The cover should be kept open slightly when the processor is not in use so that the chemical fumes can escape. Failure to do so leads to fogging of film.

RADIOGRAPHIC WASTE MANAGEMENT

To prevent environmental damage, many community states have passed laws governing to disposal of waste. Such laws often drive from the federal resource conversion and recovery act of 1976. Although dental radiographic waste constitutes only a small potential hazard, it should be discarded properly. The primary ingredient of concern in processing solution is the dissolved silver found in used fixer. Another material of concern is the lead foil found in the film packet.

Several means are available for properly disposing of silver and lead. Silver may be recovered from the fixer by either metallic replacement or electroplating methods. Metallic replacement uses cartridges through which waste solution are poured. In this process iron goes into the solution and silver precipitates as sludge.

In the electroplating method the waste solution come in contact with two electrodes through which a current passes. The cathode captures the silver. In either case, the recovered silver can be sold to silver refineries or buyers.

The lead foil is separated from the packet and collected until enough has been accumulated to sell to a scrap metal dealer. Dental office also should consider using companies licensed to pickup waste material. The name of such companies can be sound in the telephone directory or obtained from state hazardous waste management agents.

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