CHEST IMAGING: A NEW LOOK AT AN OLD PROBLEM

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The chest is one of the most complex segments of the body to examine radiographically. Comparison radiographs of the chest are challenging to an interpreter. Since radiographic technique can affect the management of the patient, it is extremely important to document the technical factors used for a chest examination. Follow-up studies must be technically consistent.

The use of a short exposure time (10 ms or less) helps stop motion. Minute vascular patterns or calcification must not be "blurred out." If one were to purchase a state-of-the art chest radiographic room, at the present time a typical recommendation would be a three phase generator with 150 kVp output combined with a 10:1 or 12:1 ratio grid. Techniques required for pneumoconiosis utilize lower kilovoltage values (approx. 110 kVp) with high ratio grids. Although the air gap technique has been popularized in Canada by Wilkinson and Fraser, this technique is not in common use in the United States.

The enactment of Public Law, 91-173, stating that every underground coal miner shall have an opportunity to have a chest X-ray examination for the purpose of establishing health and safety standards for the nations coal miners, generated new interest in chest radiographic technique.

CONTROL OF SCATTER RADIATION

Scatter radiation can segmentally damage a radiographic image. A chest radiograph can appear to be properly exposed, but portions of that image can be damaged by scatter. In a non-grid chest image, up to 65% of the radiation reaching the screen/film can be scatter. Non-grid chest radiographs are usually made at approximately 85 kVp, often with a single phase generator with a timer of questionable accuracy. Modern chest studies utilize high ratio grids with high kilovoltage values.

Common problems encountered with grid radiography of the chest include:

1. Improper processing conditions, particularly with hand processing. The use of an automatic processor does not guarantee quality radiographs unless a Quality Assurance program is utilized.
2. Grid focus. Often an improperly focused grid is used for chest radiography. If a medium focus grid (40" FFD) instead of a long focus grid (72" FFD) is used for chest radiography, a bilateral grid cutoff (approximately 2" of each side of the chest radiograph) occurs. Both costophrenic angles seem underexposed. This bilateral artifact can be interpreted as poor screen contact. Incidentally, poor centering to a grid can produce unilateral cutoff of an image. The use of a laser positioning device helps center the central ray to the grid as well as the patient to the film holder.
3. A low to moderate kilovoltage value with a high ratio grid, can be disastrous with a high contrast radiographic film. As kilovoltage is raised, for example to 140 kVp, a high ratio grid (12:1) must be used. As kilovoltage is lowered, for example to 90 kVp, a 6:1 low ratio grid is required.

   There is a difference in radiographic techniques when using either single phase or three phase equipment. Three phase radiation is virtually ripple free as opposed to single phase X-ray (100% ripple). Dramatic technical adjustments in kilovoltage must be considered, for example, a single phase 125 kVp technique requires approximately 108 kVp when using a three phase generator. Since three phase current is virtually ripple free, higher ratio grids are often required.
4. Poor inspiration. This problem is compounded when using an automatic exposure control such as a photo timer or an ionization chamber. If a patient is exposed at maximal expiration, even though the diaphragms are elevated and the cardiac silhouette is widened, an adequate density is often produced by an automatic exposure control. Proper density (blackening) cannot overcome cardiac distortion or compacting of the lungs due to expiration.

MEDIASTINAL INFORMATION

Information gained regarding the mediastinum is often at the expense of proper exposure of the lung fields. The use of a compensatory filter to "see through" the mediastinum is a substitute for a film with appropriate sensitometric characteristics. Latitude or extended latitude films are required for mediastinal information. A compensatory filter has a fixed opening for mediastinal penetration; "one size does not fit all."

THREE PHASE

If the same kilovoltage value, for example, 110 kVp is used with single phase and three phase generators, the three phase image will produce scatter similar to a single phase 125 kVp exposure. Unless, mAs values are lowered either manually or by an automatic exposure control, the three phase image will be approximately 2X overexposed. Even when an appropriate mAs adjustment is made, there is a difference in contrast with the three phase study. A higher ratio grid may be required for three phase imaging techniques. Three phase exposures are shorter than single phase exposures and help to stop motion.

AUTOMATIC EXPOSURE CONTROL

An Automatic Exposure Control (AEC) helps insure that exposures are of consistent density. The radiographer initiates the exposure but the AEC determines its length. Positioning skills are essential. Relationship of a patient to the AEC sensor must be a constant concern. In the lateral projection, if the patient moves slightly backward, a large portion of the cassette will be exposed to the primary ray. This "primary beam leak" produces considerable scatter that can strike the lateral sensor, shortening the exposure time.

When using an AEC, concern for the minimal response (minimal reaction) time of the unit is essential. The minimal response time is defined as the shortest possible automatic exposure achievable by your AEC. The use of faster screen/film combination produces more film blackening per unit of exposure, and can accentuate your minimal response time difficulties particularly with older equipment. Often, a small to medium patient will require less radiation for proper exposure of their chest radiograph, than an AEC is capable of delivering at a predetermined kilovoltage and milliampere setting. If a high kilovoltage three phase technique is used, the MRT may produce technical difficulties with more than half of your images. If a proper kilovoltage has been selected with an appropriate grid, and if your minimum response time (often 100th/sec) cannot be changed, then the milliampere setting must be lowered to match patient size. For example, a frail, approximately 100 lb. patient could require 50 mA, while a muscular adult might require 300–400 mA.

CAUTION: Never reduce kilovoltage to compensate for an MRT difficulty. A reduction in kilovoltage produces short scale contrast with blackened lungs and chalk-like osseous and mediastinal structures.

COLLIMATOR DIFFICULTIES

On occasion, an image "cutoff" can occur on a radiograph if one of the internal shutters of the collimator is out of alignment. The shutters within the collimater closest to the X-ray tube can be misaligned. If a shutter slips into the primary beam, there is a radiation cutoff. Unfortunately, the light beam pattern on the patient formed by the collimator is created by the exit shutters. A simple test to determine if this difficulty is occurring with your unit will be demonstrated during this presentation as well as during the posterboard demonstration.

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