Chapter Four

Visibility Factors

In chapter three, the two main visibility factors, mas and kvp was explained. In this chapter, let's look at different x – ray components and how they relate to radiographic density and contrast. Although this is not a book on equipment, every Radiology Technologist should understand small details about the x – ray components. By understand small details about the x – ray components, the radiographer will have a clear understanding of how these components relate to MAS and KVP.

Machine Phase

There are three types of x – ray machines: single - phase, (six pulse) three - phase, and (twelve pulse) three - phase. The frequency phase unit of a single - phase is 60 cycles. The (six – pulse) three - phase frequency pulse unit is 360 cycles. The frequency phase unit of a (twelve – pulse) three phase or a high frequency machine is 720 cycles.

These facts show, the three - phase x – ray machine is more efficient than a single - phase machine. High frequency machines are better than three – phase machines. In high frequency machines, more x – rays can be produced per second in comparison to a single – phase x – ray machine. The average energy, of a high frequency machine, never falls below a set kvp because the output of energy is constant. "When comparing a single – phase x – ray machine to a high frequency machine, the MAS used by a single – phase machine should be double in order to obtain the exact radiographic density of a high frequency machine".

In relating the three types of x – ray machines to radiographic contrast, since a high frequency machine has an increase average energy level, the penetration power is also increased. In chapter three we learned, increasing KVP or penetration power will produce a long scale of grey. This decreases radiographic contrast. In theory, "high frequency and three – phase x – ray machines will produce lower radiographic contrast in comparison to a single – phase machine". However, this is not the case because the change in contrast is not significant enough to detect visually. Therefore, the different types of x – ray machines do not play a factor in the changes of radiographic contrast.

Beam Filtration

The concept of beam filtration and its relation to radiographic density and contrast will be explained; therefore, making these relationships easy to grasp. Beam filtration occurs when aluminum filtration is added, in order to increase the quality of the x – ray beam. Some textbook refers to this concept as "hardening the beam". The aluminum will remove the low energy radiation that is not useful for diagnostic imaging and may be hazardous to the patient.

There are two types of beam filtration: inherent and added. These two types make up the total beam filtration. Inherent filtration is the filtration that normally occurs inside of the x – ray tube. The range of aluminum usually falls between 1.0 to 1.5 millimeters. Added filtration, on the other hand, is the filtration added inside of the collimator. For routine diagnostic imaging, the total filtration should be 2.5 for x – ray machines that operate at 70 KVP. If total filtration increases above 3.5 millimeters, radiographic density will be affected. Although filtration does not affect radiographic density and contrast directly, it will affect radiographic density if used in excessive amounts.

Half Value Layer (HVL)

In diagnostic imaging, the quality of the x – ray beam is recognized as KVP. Due to filtration used in radiography, this is not the case. This is why the HVL was created. The HVL measures the amount of filtration required to reduce the x – ray beam by half. In layman's terms, this is the measure of the x – ray beam penetrating ability. If the inherent filtration, added filtration, or KVP increases, the half value level will also increase.

Collimators and Positive Beam Limitation (PBL)

The collimator and Positive Beam Limitation are two components of radiographic equipment used to reduce exposure to the patient and increase radiographic contrast. The collimator is attached to the x – ray tube. It utilizes a set of manually controlled shutters, which helps to absorb off – focus radiation. Off – focus radiation occurs when electrons stray on their way to the anode. These off – focus x – rays can lead to scatter radiation and reduce radiographic contrast on the image.

The PBL is located on most modern x –ray collimators. It will automatically adjust the collimator to the size of the film in the x – ray bucky tray. This event can often lead to problems. Although the PBL is good to use for collimating, the radiographer must remember they can override the PBL. The radiographer usually does this in order to collimate further on smaller body parts. If the radiographer is not careful, he or she can over collimate, thus clipping off pertinent patient anatomy. Both the collimator and the PBL are good to utilize in order to increase radiographic density and contrast. By reducing the amount of tissue covered, less scatter will be produced. A general rule states, "Smaller field sizes will lower radiographic density, while larger field sizes will increase density". In order to maintain a given radiographic density, MAS should be increased between 35% and 50% depending on how small the field size is.

Grids

Grids are radiographic equipment used to absorb scatter radiation emitted by the body tissues before it reaches the x – ray cassette or film. There are two types of grids: stationary and moving. Gustav Bucky invented the stationary grid, which does not move. Hollis Potter invented the moving grid, which is often used today. The moving grid can be reciprocating (moving back and forth during exposure) or oscillating (moves in a circular motion). Moving grids are better to use because the reciprocating and oscillating mechanism will distort the grid lines, thus reducing artifacts. This will increase visibility of the image.

So what are grid lines? The grid lines are determined by the grid ratio. All grids have a grid ratio. The grid ratio is the efficiency of the grid in absorbing scatter radiation. Some known grid ratios are 5:1, 6:1, 8:1, 10:1, 12:1, 16:1, and 32:1. The grid ratio is usually written as a ratio, with the first number representing the depth and the second number representing the width. In relation to radiographic density and contrast, grids are very important. A general rule states, "As grid ratio increases, from smallest to the largest, the radiographic contrast will increase". This is due to the absorption of the scatter radiation. If the scatter radiation is absorbed before it reaches the film, the radiographic contrast will be better. However, grids do not have this same effect on radiographic density. When a grid is used, it will absorb some of the secondary radiation emitted from the patient. This occurrence will result in a loss of radiographic density. In order to compensate for this loss, the MAS, depending on the grid ratio, should be increased 2 to 5 times.