RADIOLOGY TECHNIQUES – IT IS JUST A BUNCH OF NUMBERS

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The road to good quality radiographs has many obstacles that prevent us from reaching our destination. The three primary roadblocks on this road are exposure factors, film development, and correct anatomic positioning and measuring. This article addresses the first two, which often slow us down and result in less than optimal, if not diagnostic radiographs.

The foremost consideration is using the correct exposure parameters. If the correct technique is not used, no matter what road you take for the remainder of the procedure; you will not reach your destination. We first need to talk about the x-ray machine and the three primary adjustable settings we can work with, kVp, mA, and time.

kVp

The most important term as far as the body part is concerned is kVp. kVp determines the gray scale in the study you are doing. The higher the kVp, the grayer the tissue. k’s = grays, which can also be called the scale of latitude. There are ideal parameters for kVp in any given study:

<table>
<thead>
<tr>
<th>Body Part</th>
<th>kVp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorax</td>
<td>80–120 kVp</td>
</tr>
<tr>
<td>Abdomen</td>
<td>70–90 kVp</td>
</tr>
<tr>
<td>Bone</td>
<td>40–65 kVp</td>
</tr>
<tr>
<td>Avian and exotics</td>
<td>40–58 kVp</td>
</tr>
</tbody>
</table>

(Depending on the species)

Some of the rules of thumb for kVp are:
1. You need to change it 10% to see a difference in technique.
2. You will never get a black radiograph, only a darker shade of gray.
3. kVp only starts penetrating over 80 kVp, meaning the body will be lacking latitude.

mA

mA is the second setting we have to work with. mA is the amount of x-rays or electrons coming out of the tube. It takes into consideration the blackness of the background and the denseness of the tissue you are radiographing. There are three primary tissue types we are concerned with when doing exposures, air, soft-tissue and bone. When we are doing a thoracic study we are shooting air. You do not need very many x-rays or electron to go through air and produce the image, so our mA can be very low. It is not usual to see a setting of 100 mA for a thorax if you have a relatively fast film/screen combination. The opposite end of the scale is a bone technique. Bone is very dense and when doing extremity you want a black background so your mA is going to be higher. You ask how much higher? There is usually a 5-fold increase between density changes. For example, if your thorax is 1.0 mAs your abdomen will be around 5.0 mAs and your bone 10–15 mAs. With this in mind an abdomen study is again right in the middle because soft-tissue is denser than air but not as dense as bone.

There are rules of thumb for mA:
1. You need to halve or double the mA to see a difference
2. Your film will be black with too much mA versus too gray with kVp.

TIME

Time is how fast your exposure time is set for. The number one reason for retaking radiographs is motion. Shortening your exposure times can eliminate motion. Try to keep your exposure time under 1/20 of a second. Thorax studies should be done at 1/120 or 1/60 of a second to eliminate motion from the natural breathing of the animal. mA x time gets the term mAs. mAs is often shown on your x-ray machine. Doubling the time is like doubling the mA.

Remembering that we need both number (mAs) and penetration (kVp) to achieve a diagnostic radiograph, our primary goal then is to apply the correct percentage of each to produce the optimum quality film. Our primary goal is to use these tools to accent the body parts we are primarily interested in. If we made our technique chart a percentage table it would look like Table 1 below.

Table 1.

<table>
<thead>
<tr>
<th>Body Part</th>
<th>mAs</th>
<th>kVp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorax</td>
<td>20%mAs</td>
<td>80%kVp</td>
</tr>
<tr>
<td>Abdomen</td>
<td>30%mAs</td>
<td>70%kVp</td>
</tr>
<tr>
<td>Pelvis, Spine Skull</td>
<td>50%mAs</td>
<td>50%kVp</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>70%mAs</td>
<td>30%kVp</td>
</tr>
</tbody>
</table>

Lots of gray scale - lungs, vessels, heart
Some gray, denser tissue - soft-tissue
Less gray, increased contrast - bone detail
Little gray, high contrast - black and white

HOW TO MAKE A TECHNIQUE CHART

As we formulate the chart, you will notice the "ideal parameters" we discussed in the previous paragraph. It is important that you keep your chart within these parameters. Establishing a good working technique chart is the most important part of this journey. There are instances when you may need to vary from these factors: e.g., increased or decreased morphologic condition of the animal, emaciation, obesity, ascites, pulmonary edema, heart failure, and other factors that could affect the density of the anatomic part being radiographed.
When making a technique chart we start with the correct kVp settings (within the parameters) for the thorax. It is then a simple matter of establishing a mAs value which at the selected kVp, results in a good quality radiograph. It is the mAs that will be different for everyone because people have different film/screen combinations and also different machines. The kVp will always stay constant. Once we have a good quality film of the thorax we will use a theory in physics called extrapolation. Extrapolation allows us to compensate and adjust the exposure factors to fit any size patient or anatomic area to be radiographed. All these factors are based on the "ideal parameter" thorax film we started our chart with. There are numerous reasons for staying within the ideal parameters. These include optimum amount of radiographic information for that particular body part, reduction in motion and image blurring, lower personnel exposure, wide margin of error, and fewer repeat radiographs due to incorrect exposures.

HOW TO MAKE A TECHNIQUE CHART

Thorax Technique
1. Use an average size dog to start (about 55 lbs) with an average body composition
2. On the chart under 17 cm put 95 kVp which is the middle of the ideal parameters for a thorax.
3. Fill out the rest of the chart according to the kVp per cm increments.
4. Obtain a lateral measurement of the thorax at the widest point.
5. Find this measurement on the chart and set your kVp.
6. Once you have your kVp then take three lateral thorax radiographs at three different mAs values remembering to keep your time as fast as possible, i.e., 0.8 mAs (100 mA, 1/120 sec) or 1.7 mAs (100 mA, 1/60 sec.) or 2.5 mAs (300mA, 1/120 sec.).
7. Select the best quality radiograph and enter that mAs value into the technique chart in the space provided. Or put the mA and the time.
8. The grid technique for thorax is now complete.

Abdomen Technique
1. For 17 cm put 80 kVp (this is the middle of the ideal parameters for abdomen).
2. Fill in the rest of the abdomen chart according to the kVp per cm increments.
3. Set the mAs value at 4X the mAs of the thorax, e.g., 5.0 mAs (200 mA, 1/40 sec.) (300mA, 1/60 sec.)
4. Your grid abdomen technique chart is done. Remember to measure the widest point of the abdomen which is over the diaphragm.

Spine, Skull, and Pelvis
1. Set the kVp value at 70 kVp under the 17 cm box.
2. Fill out the chart according to the kVp per cm increments.
3. Set the mAs value at a number 2X higher than the abdomen mAs. 10.0 mAs (300mA, 1/30 sec.) or 15 mAs (300mA, 1/20 sec.)
4. The spine, skull and pelvis technique chart is done. You can also use this for shoulder, humerus, and femur studies.

Thorax, Abdomen and Spine Table Top
1. On the grid technique chart for thorax, abdomen, and spine determine the kVp setting for 11 cm.
2. On the table top chart continue to decrease the kVp as the cm increments grow smaller. For example, if 74 kVp was used at 11 cm then you would use 72 kVp at 10 cm, 70kVp at 9 cm, etc.
3. Fill out the technique chart accordingly for each area.
4. Adjust the mAs by reducing it to half the value used on the grid chart for the same body part, e.g., if 5.0 mAs was used then reduce it to 2.5 mAs (100 mA, 1/40 sec.)
5. If the film is overexposed (dark) reduce mAs values again by half. Finding the appropriate mAs will be dependent on the ratio of the grid in the table.
6. The table top technique chart for thorax, abdomen, and spine is now complete.

Table Top Extremities (Bone)
1. Measure an average dog carpus.
2. Under the 5 cm box set the kVp at 55 (a value in the middle of the ideal parameter for orthopedics bone technique).
3. Fill in the chart accordingly to the kVp per cm increments.
4. Set the kVp of the average carpus and take three radiographs at three different mAs settings (you may use 100 mA at 1/60, 1/40 and 1/30 sec).
5. Select the best film and enter your mAs (mA and time) and your bone tabletop technique chart is done.

Avian and Exotics
1. Set the kVp at 45 kVp in the 5 cm box and fill in the chart according to the kVp per cm increments.
2. Set your mA for the same as tabletop bone. If the radiograph is overexposed (dark) halve your mAs value.

You now have seven complete technique charts which should be posted by your X-ray machine. Also, it is important that you write your technique down so that if you have to repeat the radiographs at another time you can use the same settings and get comparable films.