**LABORATORY PRACTICE #1**

**Determining Density, Contrast and Gray Scale Changes**

**PART A**

**Procedure:**

Expose a knee phantom on two masked-off halves of a 10 x 12 inch 200-speed screen cassette on the tabletop using the following techniques. Be sure to label Exposure #1 and Exposure #2 with lead markers. Process your film.

Exposure #1: 100 mA, 1/50 (0.02) sec., 60 kVp

Exposure #2: 100 mA, 1/50 (0.02) sec., 90 kVp

Alternate Techniques:

Exposure #1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exposure #2 (50% increase in kVp): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis:**

1. Density:
2. Estimate visibly on an illuminator how much darker Exposure #2 is than Exposure #1. Express this as a *factor*, e.g., 1.25 times darker, 1.50 times, 2 times, etc.
3. Select an area within the *bone* image which has a fairly homogeneous density. This area should not have trabecular lines running through it as in the marrow but should consist of compact homogeneous bone. Where there are many small details of differencing densities, the accuracy of your measurements on a densitometer is reduced, because it averages out the detail densities covered by its aperture and it is difficult to place the densitometer aperture *exactly* over the identical spot for each film. Circle this area on both radiographs with a grease pencil or marker and label it *A*. *Select an area within* the phantom image which represents a soft-tissue density. A wide portion of an open joint space is a good area for this. This density area must be quite different than the first one in order to obtain good contrast measurements. In this case, it should be considerably darker than the first area found in the bone. Circle this area with a grease pencil or marker and label it *B*. Check to make sure that the densitometer is zeroed properly by taking a measurement without any film in it. If it reads within 0.02 of zero, it is close enough. Take measurements of the circled areas on your radiographs and record them below. Be careful to place the densitometer aperture only over the area of interest, without adjacent differential densities under it. Record the measured densities as Exposure #1 Area A density, Exposure #1 Area B density, Exposure #2 Area A density, and Exposure #2 Area B density.
4. Compare only the *Area A* densities between Exposure #1 and Exposure #2. Which exposure is densest?
5. Divide (using a calculator, if available) the lesser Area A density number into the greater. The number you get will be the density change ratio (abbreviated ∆D), and represents the factor by which one exposure is darker than the other. Record this number as ∆D.
6. Densitometers measure darkness at the same proportions as the human eye sees it. Compare your ∆D measured with the densitometer to the visual estimate you made in Question #1 above. Are they close? Which one do you trust more?
7. *Contrast*: Contrast is determined by comparing two densities on the same film.
   1. On an illuminator, visibly estimate which exposure has a greater *difference* between Area A and Area B. Which exposure has a higher contrast?
   2. Calculate the *contrast* for each film by dividing the smaller density number (Area A) into the larger (Area B) and record them.
   3. Which exposure has higher measured contrast?
   4. Does this agree with your answer to Question #1?
   5. Calculate the contrast change ratio (∆C) by dividing the smaller contrast number into the larger. How much *more* contrast does one exposure have than the other?
8. *Sharpness*: Sharpness may be accurately measured on the image of a special resolution pattern device which will be described in a later experiment. For the first several experiments, however, sharpness will be estimated visibly by choosing an edge of bone or other anatomy and observing whether it abruptly stops or gradually fades into the adjacent density. **DO NOT** confuse contrast with sharpness. An image may look *brighter* against the background density, but the edge may not be any sharper.

Closely examine the same portion of the same edge of bone on Exposure #1 and Exposure #2. Is one sharper than the other? If so, which?

**PART B**

**Procedure:**

Expose a step-wedge penetrometer on two masked-off halves of a 10 x 10 inch 200-speed screen cassette on the table top using the following techniques. Label Exposure #1 and #2 with lead markers. Process the film.

Exposure #1: 5 mAs, 40 kVp

Exposure #2: 1 mAs, 85 kVp

Alternate Techniques:

Exposure #1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exposure #2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis:**

1. Count the number of *different shades of gray* that are discernible as different steps on each exposure, and record. This is the gray scale.
2. Select a medium-gray step on Exposure #1 and measure its density with a densitometer. Then measure the density of the step that is *two* shades lighter (two steps “down”). Record both numbers. Repeat this procedure for Exposure #2.
3. For each exposure, divide the darker density by the lighter density to obtain the *contrast*, and record.
4. From Question #1, which exposure has longer gray scale (more shades of gray)?
5. From Question #3, which exposure has higher contrast?
6. What is the relationship between contrast and gray scale?