Name: _____ Date: _____ Team: _____

Lab Experiment # 8

Evaluating Histograms Across Anatomical Regions and Exposure Variations in Digital Radiography

Purpose

The purpose of this lab is to develop an understanding of how histograms function in digital radiography and how they are affected by body part selection and exposure factors. Students will analyze the shape, position, and width of histograms across different anatomical regions and exposure techniques, and relate these changes to image quality, exposure indicator accuracy, and potential errors in image processing.

Learning Objectives

After completing this lab, you should be able to:

1. Use the laboratory equipment properly.
2. Set up the control console and ceiling tube mount correctly.
3. Function effectively in group work.
4. Perform the experiment independently.
5. Interpret histograms in relation to different body parts and exposure conditions.
6. Explain how histogram analysis and DI values can be used to optimize image quality.
7. Predict how changes in mAs and kVp influence histogram shape, image quality, and patient dose.

Materials Needed

- 14 x 17-inch wireless digital (DR) image receptors.
- Whole body phantom phantom
- Set of lead numbers
- Lead rubber sheets

Procedure Direct Radiography

Instructions for Exposures 1 through 12

1. Place the wireless digital (DR) image receptor in the table bucky and set the SID to 40 inches.
2. Position the Body phantom on the table.
3. Direct the central ray **to the center of the anatomy of interest.**
4. Tape the appropriate ID markers onto the image receptor within the collimated light field so they do not obscure any areas of interest.
5. Set the x-ray tube, mode of operation, and focal spot size as indicated on the worksheet.
6. Make all the exposures using the settings indicated on **the Worksheet**.
7. For each radiographic image acquired in this lab, analyze the histogram displayed on the system and complete the following:

   a. Observe the histogram carefully for each body part (e.g., chest, abdomen, extremity).
   b. Sketch the shape of the histogram in the space provided. Your drawing should reflect:

      - The overall width (narrow vs. wide)
      - The peak(s) of the distribution
      - The position (shifted left, centered, or shifted right)

Brief Discussion

In digital radiography, the histogram represents the distribution of pixel values within an image and plays a central role in image processing. Each anatomical region produces a characteristic histogram shape based on its composition. For example, a chest image typically shows a wide distribution due to the presence of air and soft tissue, whereas an abdominal image shows a narrower distribution with more uniform attenuation.

Exposure factors, particularly mAs, directly influence the number of photons reaching the image receptor. As mAs increases, receptor exposure increases, reflected as a shift in the histogram position. However, image brightness is controlled by post-processing, so incorrect exposures may not be visually obvious, increasing the risk of overexposure.

kVp also influences the histogram by affecting beam penetration and subject contrast. Higher kVp reduces subject contrast and produces a more uniform range of pixel values, often resulting in a more compressed (narrower) histogram distribution. Lower kVp increases contrast and may broaden the histogram.

When the exposure technique is grossly incorrect (either excessive or insufficient), the histogram can be significantly distorted. In these cases, the system may fail to properly recognize the anatomy or correctly apply processing algorithms. This can result in images that appear artificially acceptable or, conversely, severely degraded despite post-processing. Excessive exposure may produce low-noise images with loss of contrast, while insufficient exposure increases noise and reduces diagnostic quality.

Understanding how mAs and kVp affect histogram appearance and DI values—and recognizing when the histogram is unreliable due to extreme technique errors—allows the technologist to make appropriate adjustments. This supports consistent image quality while minimizing unnecessary patient radiation exposure.

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Worksheet 1

Direct Radiography Image Receptor

	kVp	Focal Spot	SID	mAs	Body Part	Shape of the histogram
1	**64**	small	40”	**1.1**	**Hand AP**	
2			40”		**Elbow AP**	
3			40”		**Shoulder AP**	
4			40”		**Chest AP**	
5			40”		**Pelvis AP**	
6			40”		**Knee AP**	
7			40”		**Ankle AP**	
8			40”		**Foot AP**	

Worksheet 2

	kVp	Focal Spot	SID	mAs	Body Part	Shape of the histogram
9	64		40”	2.5	Hand AP	
10	64		40”	5	Hand AP	
11	64		40”	10	Hand AP	
12	64		40”	20	Hand AP	

The same body part was imaged using four different mAs settings. Analyze the corresponding histograms and answer the following:

1. Compare the histograms for the same body part across all four exposures.
2. Describe how the histogram position shifts as mAs increases.
3. Determine whether the shape and width of the histogram change significantly or remain consistent.
4. Record the **Deviation Index (DI)** for each exposure and relate it to the observed histogram shift.
5. Identify which exposure produces a **DI closest to target (0)** and explain why.
6. Based on your observations, explain the relationship between **mAs, histogram position, and receptor exposure**.