General Radiographic Image Artifacts

The Art of the Image: The Identification and Remediation of Image Artifacts in Projection Radiography, part II

Alisa Walz-Flannigan, Ph.D. DABR
Mayo Clinic, Rochester, Minnesota
Walzflannigan.alisa@mayo.edu

American Association of Physicists Meeting, Indianapolis
8/7/2013
Types of Radiographic Artifacts

• Acquisition Artifacts
  • Object in beam-CR/DR
  • Backscatter-CR/DR
  • Grid issue-CR/DR
  • Over/underexposure- CR/DR

• Detection artifacts
  • Dirt and dust in reader-CR
  • Imaging plate damage-CR
  • Dead lines/pixels/detector - CR/DR

• Signal Processing Artifacts
  • Bad plate erasure-CR
  • DR lag-DR
  • Saturation-CR/DR
  • Flawed or limited flat-field compensation
  • or shading correction –CR/DR

• Signal Transmission Artifact
  • Readout failure or interference-CR/DR

• Image Processing or image construction issues (stitching)-CR/DR

Could arise from any point in the imaging chain.
Acquisition Artifacts

• Grid issue
• Backscatter
Suppression of anti-scatter-grid lines in an image is handled by a number of mechanisms:

1. Moving grids - Buckys
2. High line rates
3. Grid Removal Software

Wrong line-rate grid
Grid positioned transverse; grid removal software failed

Windowed to show grid-lines
**Wireless detector**

- Backscatter through the back of the detector.
- Frequently seen with large patients.

Temporary fix: place lead aprons behind the detector.

Longer term fix: More shielding attached to the back of the detector; provided by vendor.
Detection Artifacts

- Dirt and dust in reader
- Imaging Plate damage
Dirt and dust in the reader.

Resolved itself.
Dirt and dust in the reader.

Reader cleaned.
Ghosting on dedicated chest CR imaging plate

1mR exposure

Default clinical window-level

20% window

Repeated exposures of similar profile created a ghost. Plates with significant ghosting are replaced.
Phosphor wear

1mR exposure

Default clinical window-level

20% window
Roller damage
Resolution: Oxivir no longer used for cleaning cassettes for infection control. Switched to SaniCloth.
Dead line, processed
Signal Processing Artifacts

• Bad plate erasure
• DR lag
• Saturation
• Flawed or limited flat-field compensation or shading correction
Latent image in CR from incomplete erasure of previous image.

Visible in regions of high attenuation
Latent image test for that reader

50mR with Cu square

Same plate, 0.1mR no Cu square
Another example of latent image in CR
DR Lag

Lead marker from prior image is visible
DR Lag
Stitched image

6 seconds later

18 seconds later
Inverse of DR Lag; Lag signal is recorded in signal offset map.

Resolution: Software update from vendor which handles detector lag differently.
Variation in saturation thresholds visible in raw radiation.
Not a clinical artifact but sometimes asked about by technologists.
Shows the saturation threshold behavior ascribed to the previous image.

7 mR, 80kV, 100 mA, 60 ms

8.4 mR, 80 kV, 100 mA, 71 ms
Structure visible in raw radiation.
Not a clinically relevant artifact
Structure visible in raw radiation.
Not a clinically relevant artifact
Visible detector structure in anatomy
The corduroy artifact seen in the anatomy is caused by a combination of uniformly-spaced components within the detector and the sampling rate in the acquired image.

Resolution:
Software update by vendor that changed the sampling rate fixed the problem.
Slot scan system
Lines visible in rapid readout

Resolution:
Slower scan speed.
Defect in calibration. Visible with change in SID.

Resolution: New filter and recalibration.
Visible detector tiling

Seen with room temperature change and use.

Resolution: recalibration; room temperature stabilization
Visible detector tiling

Particular to this view and technique. This artifact is not resolved by detector calibration.

w/l adjustment to better show quadrants
Speckle artifact, after detector drop. Gd$_2$O$_2$S Detector

Resolved by re-calibration
Speckle artifact. Gd$_2$O$_2$S Detector
Signal Transmission Artifacts

- Failed readout or interference
Reader hesitation
Plate feed error
Attenuation difference at top half of image is from plexiglas used for positioning.

Readout interference.
Readout interference
Source: Bumped during readout
Readout failure

Source: unknown
Resolution: Rebooted the system a few times. Recalibrated the detector.
Image Processing or image construction issues

- Histogram clipping
- Other poor processing
- Image Composition (“stitching”)
Issue: Histogram clipping. Image data outside of the Values of Interest are discarded and not recoverable.

Resolution:
Re-processed the images under a different setting with a fixed latitude
This issue is addressed by an upgrade to vendor software.
Issue: Image processing failure/Overexposure

The detector is not saturated. Image data in the region is recoverable. However, it is difficult to see and must have an extreme window/level to be made visible. It is often seen with small patients in lateral chest images.

Resolution: By selecting “-1” exposure compensation brings the pixel values into a range which fares better with the image processing and remaining image quality is sufficient.
Issue: Incomplete image processing from incorrect shuttering. Electronic shutter which selects region for processing triggers on the wrong area.

Resolution: Shuttering can be manually modified.
VOI LUT not received or recognized

VOI LUT recognized

Issue: VOI-LUT is not transmitted because of incorrect configuration. For the same system, this VOI-LUT is not recognized by downstream viewers.
Different projections of the same object are combined into a single image.

Resolution: Vendor employs a different method for stitching where the source is stationary.
General Considerations

• Know how your system works (mechanics/image formation) in order to know what the risk areas are for artifacts and how to troubleshoot

• We rely on technologists to find and report clinical artifacts
  – Promote a culture of safety which encourages reporting
  – Teach techs about what they should be looking for with different systems
Discussion

The Art of the Image: The Identification and Remediation of Image Artifacts in Projection Radiography, part III

3 mammography cases
3 general cases
Flat Field Test

Case A
Case B

View: LCC
kVp: 28
mAs: 127
Compression Thickness: 7.2 cm
Compression Force: 20.9 lbs
kVp: 28  
mAs: 75  
Compression Thickness: 5.0 cm  
Compression Force: 20 lb  

Case B
View: Flat Field
kVp: 28
mAs: 65
Compression Thickness: N/A
Compression Force: N/A

Case B
CasE C
Calk Like Artifact RCC

View: RCC
kVp: 26
mAs: 65
Thickness: 39 mm
Calc Like Artifact - LMLO

kVp:
mAs:
Compressed Thickness:
Compression Force:
Exposure Index:

Case C
Case D
CasE E
CasE F