James M. Kofler, Ph.D. Mayo Clinic Rochester

IDENTIFYING IMAGE ARTIFACTS, THEIR CAUSES, AND HOW TO FIX THEM: COMPUTED TOMOGRAPHY

> AAPM Annual Meeting 2016

"Ring" Artifact?



(Frame from animation in presentation)

Star Pattern caused by...



...metal earrings!

Same star artifact commonly caused by...











Dental Amalgam

Metal Implants

Metal Objects (wires, syringes, bullets, etc.)

• Description

- Star pattern
- Obvious, and interferes with diagnostic content
- Typically easy to determine cause
- Cause
 - Metal (high atten.) in FOV
- Remedy
 - Tilt gantry, avoid if possible
 - Increase kV, mAs (diminishing returns)
 - Metal Artifact Reduction algorithms

Case 1: Important Points

Look at the localizer radiograph

• Description

- One or more concentric rings in image
- Subtle to obvious
- Cause typically straightforward

Ring Artifact



Ring Artifact



Service was called

(Frame from animation in presentation)

Bad Detector Module



Ring Artifacts from Photon Starvation



• Description

- One or more concentric rings in image
- Subtle to obvious
- Cause typically straightforward
- Cause
 - Detector(s) imbalance/malfunction or blocked
 - Photon starvation
- Remedy
 - Service
 - Increase technique, if possible

Case 2: Important Points

- Ring artifacts common
- Usually requires Service
- Scrolling can help visualize
- Check centering
 - Patient not always centered but rings are

• Description

- Some shape superimposed on images
- Can be subtle but usually obvious
 - Usually doesn't mimic pathology
- Not intermittent



Cushion in FOV during morning calibration

WE-G-209-2 Artifacts: CT

• Description

- Some shape superimposed on images
- Can be subtle but usually obvious
 - Usually doesn't mimic pathology
- Not intermittent
- Cause
 - Object scanned during calibrations
- Remedy
 - Re-calibrate

Case 3: Important Points

On't overlook the simple things

• "Object" could be cushion, pillow, phantom, etc.

• Description

- Dark "blotches" on head scan
- Not too subtle but mimic critical pathology
- Not intermittent

Normal (prior from previous day)

"Diffuse right hemispheric abnormalities" -Very serious



QA Phantom from Morning QC



WW: 400, WL: 0 *Typical abd settings*

QA Phantom from Morning QC



WW: 100, WL: 0 ACR settings

QA Phantom from Morning QC



WW: 40, WL: 0 Better settings?

• Description

- Dark "blotches" on head scan
- Not too subtle but mimic critical pathology
- Not random
- Cause
 - Contrast material on gantry window

Remedy

- Wipe off gantry
- Note: Make sure not calibrated into system

Case 4: Important Points

- Morning QAs must be reviewed carefully using appropriate ww/wl
- Suspected artifacts must be reported
- Inspect gantry between every patient for contrast spillage, if needed. Clean with water and tissue/cloth (no soap/disinfectants)
- Known spills should be cleaned immediately

• Description

- Irregular dark bands
- Very subtle (2-3 HU) and mimics pathology
- Intermittent, very infrequent

This is the most challenging, and most dangerous, type of artifact

Suspected cerebral edema - Very serious - Patient transferred by ambulance 45 miles from remote site



Happened with 2 different patients within 24 hours

WE-G-209-2 Artifacts: CT

Morning QA images - 2 of 12 showed very subtle artifact



Both at WW: 40, WL: 0

Service was called

Description

- Irregular dark bands
- Very subtle (2-3 HU) and mimics pathology
- Intermittent, very infrequent

Cause

Air bubbles in tube cooling system

Remedy

Repair by Service

Case 5: Important PointsWW / WL very important



400 / 40

100 / 0

40 / 0

Alert staff of intermittent issue

Case 6 (last one!)

Description

- Partial "rings" not centered over isocenter
- Very obvious, does not mimic pathology
- Intermittent, very infrequent



(Frame from animation in presentation)



(Frame from animation in presentation)

Case 6 (last one!)

Description

- Partial "rings" not centered over isocenter
- Very obvious, does not mimic pathology
- Intermittent, very infrequent
- Cause
 - Moving air bubbles in patient

Remedy

- No remedy—just identify
- See it once and recognize forever!

Clinical Image Artifacts

- Se familiar with common artifacts
 - How to recognize
 - How to address
- Trouble shooting
 - Start with the simple sources
- Communicate concerns
 - Call Service when necessary
 - Provide sample cases, if possible
 - Let staff know of any potential problems
- Technologists should be diligent

References:

- Hsieh J., <u>Computed Tomography: Principles, Design, Artifacts</u>, and Recent Advances (Chapter 7), SPIE Press, Bellingham, WA, ISBN 0-8194-4425-1.
- Computed Tomography Quality Control Manual, 2012, American College of Radiology. <u>http://www.acr.org/Education/Education-</u> <u>Catalog/Products/8336734</u>
- Barrett JF, Keat N, Artifactis in CT: Recognition and Avoidance, Radiographics 2004; 24:1679-1691.
- Hedrick WR, Markovic MA, Short JA, Vera CD, Computed Tomography Artifact Created by Air in the X-ray Tube Oil, JCAT, 40(1) 2016.
- Liu F, Cuevas C, Moss AA, Kolokythas O, Dubinsky TJ, Kinahan PE, Gas Bubble Motion Artifact in MDCT, AJR: 190, Feb 2008.



Artifact from Tube Arcing

WE-G-209-2 Artifacts: CT

(Frame from animation in presentation)