ARTIFACTS IN COMPUTED TOMOGRAPHY
ARTIFACT

• Any discrepancy between the CT numbers represented in the image and the expected CT number based on the linear attenuation coefficient.
<table>
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<th>Appearance</th>
<th>Cause</th>
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<tr>
<td>Streaks</td>
<td>Improper sampling of data; partial volume averaging; patient motion; metal; beam hardening; noise; spiral/helical scanning; mechanical failure</td>
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<tr>
<td>Shading</td>
<td>Partial volume averaging; beam hardening; spiral/helical scanning; scatter radiation; off-focal radiation; incomplete projections</td>
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<tr>
<td>Rings and bands</td>
<td>Bad detector channels in third-generation CT scanners</td>
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APPEARANCE OF ARTIFACTS

STREAKS
SHADING
BANDS
RINGS
SOURCES OF ARTIFACTS

• Patient
• Imaging process
• Equipment
PATIENT INDUCED ARTIFACTS

• Motion
• Beam hardening
• Metal artifact
• Out of field artifact
MOTION ARTIFACT CAUSED BY:

- Voluntary motion
- Involuntary motion

Both voluntary and involuntary motions appear as streaks that are usually tangential to high-contrast edges of the moving part.
MOTION

A

B

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PERESTALTIC MOTION
MOTION

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REMEDY:

• **Voluntary motion**: explanation of the procedure and good communication with a patient

• **Involuntary motion**: short scan time
Correction of motion artifacts can also be accomplished with software such as underscan weighting or physiologic gating.
BEAM HARDENING

• It occurs when the average energy of an x-ray beam passing through the patient increases. Beam is “hardened” high energy photons are attenuated less by the tissue. As a result, they are passed through the patient and reach the detectors. This artifact is also called “cupping” artifact because the hardening is most pronounced in the center and less at the periphery.
COMMON AREAS OF MANIFESTATION:

• Skull – Petrous Pyramids
• Upper chest and shoulders
• Hips
BEAM HARDENING - CONTRAST

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BEAM HARDENING
REMEDY

• Increase kVp
• Use correction software
• Appropriate filtration – bowtie filter
METAL ARTIFACT

- Manifest itself as “star streaking” artifact. It’s caused by presence of metallic objects inside or outside the patient. Metallic object absorbs the photons causing an incomplete profile.

Metallic materials such as prosthetic devices, dental fillings, surgical clips, and electrodes give rise to streak artifacts on the image.
METAL ARTIFACT

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METAL ARTIFACT

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REMEDY

• Removal of external metallic objects
• MAR software
• Gantry angulation
• kVp increase
• Thin slices
ANGULATION

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MAR CORRECTION
OUT OF FIELD ARTIFACT

• Patient is not entirely enclosed in the scanning field of view. Patients body can obstruct detectors. In addition, patient tissue outside the sfov will further harden the x-ray beam. Artifact appears as streaks and shading.
OUT OF FIELD ARTIFACT
OUT OF FIELD ARTIFACT

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OUT OF FIELD ARTIFACT
REMEDY:

- Selection of larger SFOV
- Raising patients arms above their head on the scan of chest and abdomen
EQUIPMENT AND IMAGING PROCESS ARTIFACTS

- Partial volume effect
- Aliasing
- Photon starvation (noise)
- Air Contrast Interface (edge gradient) artifact
- Ring
- Tube arcing
- Line in topogram
- Staircase (Step)
- Cone Beam and Windmill artifact
PARTIAL VOLUME EFFECT

- Mechanism of partial volume artifacts, which occur when a dense object lying off-center protrudes part of the way into the x-ray beam.
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X-ray source

Collimator

High-density object

Detector

A \[ \ln(l_1 + l_2) \neq \ln(l_1) + \ln(l_2) \]

B \[ \ln(l_1) \quad \ln(l_2) \]
REMEDY

• Thin slice selection
• Smaller reconstruction incrementation
Aliasing artifacts resulting from 50% of the normal number of views used to scan this torso phantom. The artifacts are apparent at the periphery of the phantom.
REMEDIY

• Increase scan time
• Use complete Arc (360 deg.)
• Reduce pitch
PHOTON STARVATION - NOISE

• Fluctuation of CT # between points in the image for a scan of uniform material such as water.
NOISE

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REMEDY

- Increase technique
- Slice thickness increase
AIR-CONTRAST INTERFACE
(Edge Gradient)
REMEDIY

• Change the patient position
RING

• Malfunction of a detector in a third generation scanner
RING

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REMEDY

- Detector calibration
- Detector replacement
TUBE ARCING

• Tungsten vapor from anode and cathode intercepts the projectile electrons intended for collisions with the target. Crackling sound!!!! Electrical surge within the tube.
TUBE ARCING

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REMEDY

• Tube replacement (call service)
LINE IN TOPOGRAM

• Bad detector causes continuous line on the topogram.
REMEDI

• Detector replacement (call service)
STAIRCASE

• Improper selection of slice thickness and slice incrementation when generation MPR or 3-D images
STAIRCASE
STAIRCASE

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REMEDY

• Thin slice use
• 50% overlap on recon slice incrementation
Cone Beam Artifact
Cone beam artifacts are unique to the cone beam geometry of MSCT systems. Cone beam artifacts typically appear similar to partial volume artifacts. In theory, cone beam artifacts worsen as the number of detector rows increases. However, manufacturers address the issue by employing specialized cone beam reconstruction algorithms to compensate for potential errors. Example FDK algorithm.
also referred to as z-spacing or interpolation artifact. This artifact may occur from the use of increased pitch during a volumetric acquisition. The term windmill artifacts comes from the spiraling appearance of shading artifact that appears as a large number of volumetrically acquired images are paged through for review.