

THE READING HOSPITAL  
SCHOOL OF HEALTH SCIENCES  
MEDICAL IMAGING PROGRAM

BASICS OF CT--2021



ARTIFACTS & CONTRAST AGENTS  
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# ARTIFACTS IN CT

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## ARTIFACTS

Any discrepancy between the reconstructed CT number and the true CT coefficient number (HU) of the object being scanned

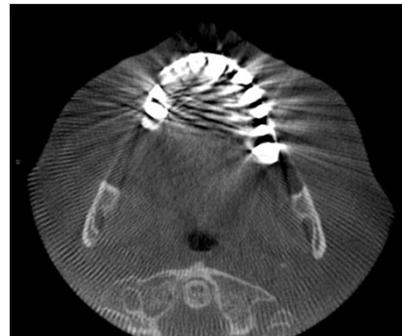
- May be user related, system related, or related to patient motion
  - Could be caused by one or a combination of reasons

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## ARTIFACT AFFECTS

- Image quality
- Decrease in spatial resolution (detail)
- Distortion

\*\*Patient Induced &  
Equipment Induced Artifacts



<http://drgstoothpix.com/2012/01/12/cone-beam-ct-caries-interpretation/>

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## PATIENT INDUCED ARTIFACTS TO DISCUSS:

- Beam Hardening
- Motion
- Metal
- Out of Field

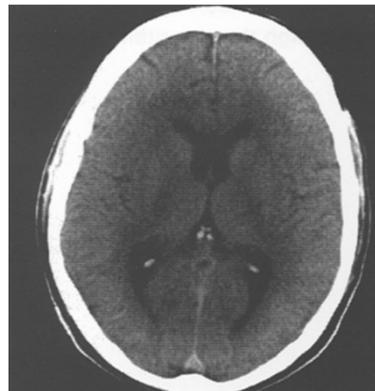


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## BEAM HARDENING

A result of the attenuation of the beam as it passes through the patient

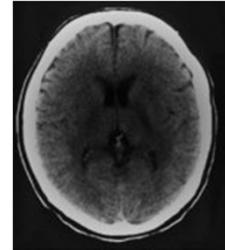
- Increase in the average energy level of the x-ray beam as it penetrates tissues
- Degree of beam hardening dependent upon body part being penetrated and its' composition



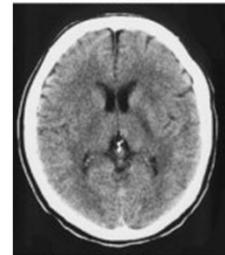
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## BEAM HARDENING

- Appearance: Dark bands or streaks (near bones/thick body parts)
  - “Cupping effect” -CT numbers higher at the periphery and lower in the center



**Beam hardening with cupping**



**Normal CT scan**

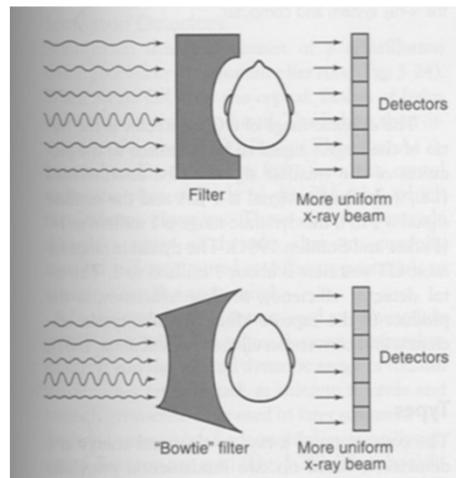
<https://www.dotmed.com/news/story/18437>

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## BEAM HARDENING

### Correction Methods:

- Correction algorithms
- Bow tie filter
  - Select appropriate SFOV
- kVp



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## MOTION

Voluntary or involuntary patient motion during the CT scan

- A tissue is in approximately one location for several projections and slightly displaced for several more projections
- Faint hint of tissue borders will be seen in both locations on the reconstructed image
- Appearance:
  - Blurring or ghosting (double edge)
  - Streaking



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## **MOTION**

*Correction Methods:*

- Patient understanding and cooperation
- Restraint/Immobilization aids
- Reduced scan times
- Abdominal correction algorithm for peristalsis
- Have patient lightly bite tongue for neck scans

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## METAL (STREAKING)

Anything metal within the scan field of view will produce an artifact

- Attenuation of nearly 100% of beam
- Produces incomplete projection
- Affected by quantity of metal, composition and shape of metal, and slice thickness
  - May make artifact more or less severe
- Appearance: Star or streaks coming from the object

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## METAL (STREAKING)

### Correction Methods:

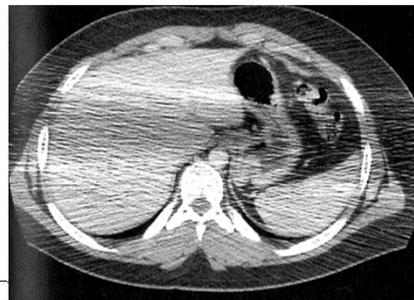
- Correct by minimizing the amount of metal in the scan field of view
- Have patient remove jewelry, hair pins, glasses and dentures
- Angle the gantry around metal dental work
- Have patient change into a gown

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## OUT-OF-FIELD ARTIFACT

Anatomy that extends beyond the scan field-of-view contributes towards the attenuation and hardening of the x-ray beam (by adding thickness)

- Variation and inaccuracy of the CT numbers of the tissues in the final images
- Dependent on the amount and density of the anatomy outside the field.
- Appearance: Streaks or shading

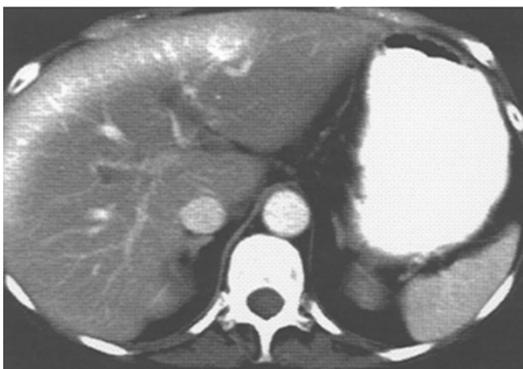


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## OUT-OF-FIELD ARTIFACT

### Correction Methods:

- Ensuring that all anatomy is in the scan field-of-view (larger field of view)
  - Have patient raise arms for body scans
    - Reduces beam hardening
    - Reduces patient's overall diameter



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Table 6

### Edible Intraoral Foreign Bodies: Appearance on CT Scans<sup>50</sup>

Type of Foreign Body	Radiodensity (HU)	Characteristic Appearance on CT
Jawbreakers	475	Laminated appearance with concentric circles of variable radiodensity; collapsed mucosa surround candy
Lemonheads	323	Spherical; outer shell has higher attenuation than interior; collapsed mucosa surround candy
Werther's Original	411	Homogeneously attenuating; depending on imaging plane, can appear circular or indented in center
Life Savers	464	Characteristic ring configuration when intact; can be mistaken for an enlarged blood vessel or dental hardware when crushed
Tic Tacs	335	Easily misidentified as a calcified tumor, displaced tooth, or jaw malformation
Starbursts	347	Homogeneous internal radiodensity; when chewed, can be mistaken for an enhancing mucosal mass
Tootsie Rolls	357	When chewed, resemble plaque-like mucosal lesions
Bubble Yum	290	Interior shows small air locules; could be confused with a soft-tissue mass, hematoma, or abscess
Eclipse gum	383	Highly attenuating; could be mistaken for a bone or excrescence

Abbreviations: CT, computed tomography; HU, Hounsfield units.

RADIOLOGICTECHNOLOGY, July/August 2014, Volume 85, Number 6

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## EQUIPMENT INDUCED ARTIFACTS TO DISCUSS:

- Partial Volume Averaging
- Edge Gradient Effect
- Ring
- Tube Arcing

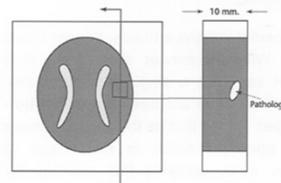


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## PARTIAL VOLUME AVERAGING

Mathematical averaging of various attenuation values from several millimeters of different types of tissue

- If several types of tissue are represented in a voxel, the average gray value is used
- Displayed as a single shade of gray on the final image
- Appearance:
  - Blurring at the margins of an object
  - Mistaken pathology



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## PARTIAL VOLUME AVERAGING

### Correction Methods:

- Utilize thinner slices
  - Causes noise- so mAs will have to be increased= increase patient dose
- Repeat the scan and have overlap (shifting slices slightly up or down)

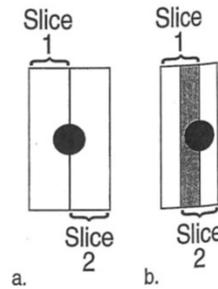


Fig. 3-10

a: If a lesion falls exactly halfway between two contiguous slices, it may not be visualized well.

b: If the slices are overlapped, the lesion may be more completely contained in one of the slices and, thus, be better visualized.

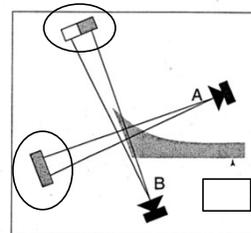
\*From ASRT CT Modules

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## EDGE GRADIENT EFFECT

Sampling around a very complex structure in the scan field of view

- Detector data is inconsistent and is dependent on the perspective of the projection
- Produces an uncertainty in CT numbers
- Appearance: Streaks emanating from an object with sharp edges or an object that has a vast density difference from surrounding tissue
  - Bone and soft tissue; air and contrast media (variations)

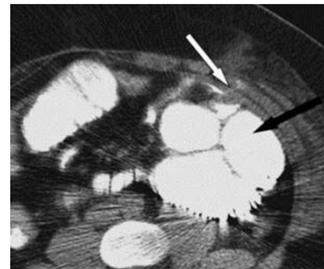
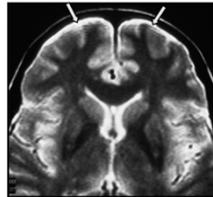
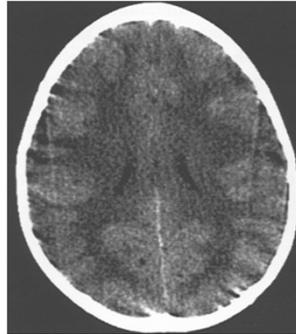


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## EDGE GRADIENT EFFECT

### Correction Methods:

- Move the object out of the scan field of view
- Use thinner slices
- Reconstruction algorithms



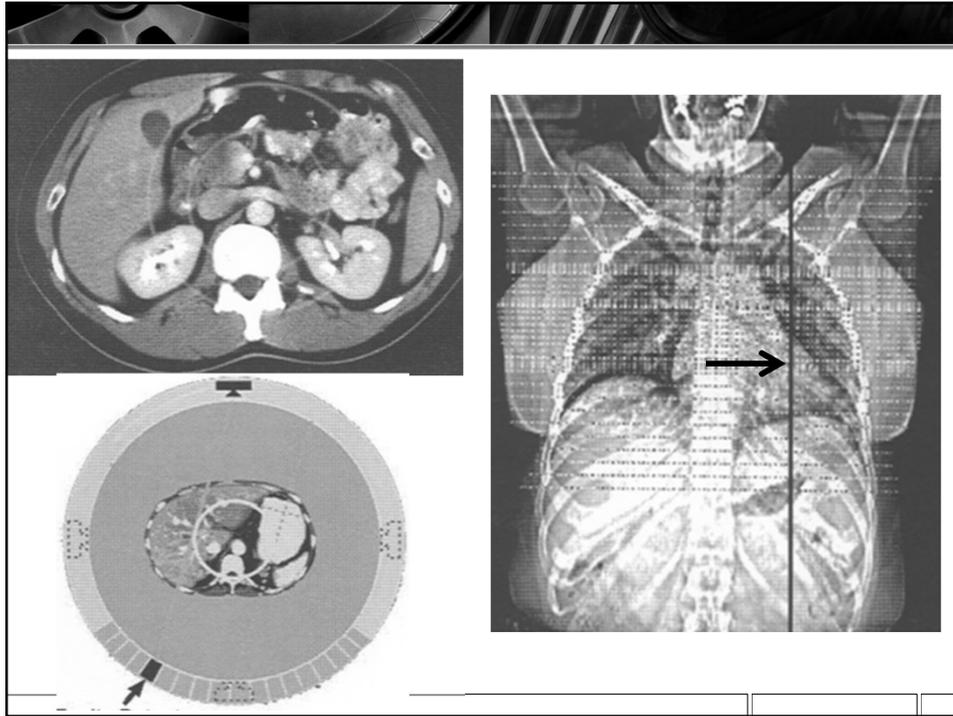
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## RING ARTIFACT

When a single detector goes out (malfunction) of calibration and does not record the incoming attenuation data that the projection or view includes

- If a detector is less than 0.1% off there will be an artifact
- Seen in third generation scanners
- Appearance: A concentric ring or circle on the raw data/reconstructed images
  - Appears as a straight line on a scout film (localizer scan)
- Correction Method: Calibration

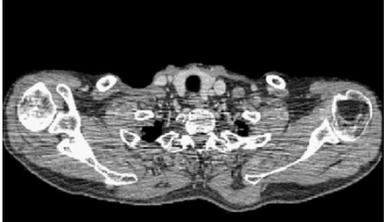
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## TUBE ARCING ARTIFACT

- Caused by an undesired surge of electrical current in the x-ray tube
- Appearance: No specific pattern- dependent on severity and frequency of tube arcing
  - Single streak to severe mottle
- Correction Method: Call service

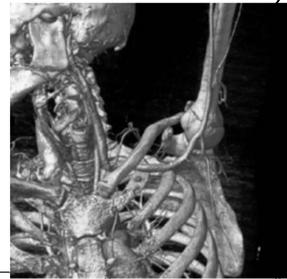
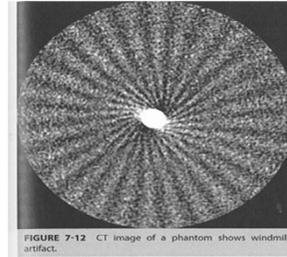


The image shows an axial CT scan of the abdomen. The scan exhibits a significant mottled and streaky artifact in the central region, which is characteristic of tube arcing. The surrounding anatomical structures are visible but partially obscured by the noise.

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## CONE BEAM EFFECTS

- Only seen in helical scanning
- Similar to partial volume effect because artifact occurs from the edge of the
- Appearance: windmill artifact
  - Wider collimation causes more artifact due to the cone shaped x-ray beam
  - Zebra artifact
- Correction Methods: Utilize recommendations from the manufacturer (such as not utilizing all detectors for data acquisition) or newer technologies have algorithms to correct



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## CONTRAST IN CT

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## CONTRAST AGENTS

**Purpose:** Used to improve the sensitivity and specificity of clinical diagnosis.

- Improve contrast between enhancing structures.
- Increase tissues ability to attenuate the x-ray beam
- Used to demonstrate lesions and staging
- 4 Methods of utilizing contrast:
  - Intravenously injected
  - Orally or Rectally
  - Intrathecal (myelography)
  - Intraarticular (arthrography)

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## INTRAVENEOUS CONTRAST AGENTS

Compounds that contain iodine and are injected into a vein in the patients arm via catheter.

- Attenuation is directly related to the concentration of the iodine
  - Bolus of contrast may be utilized
  - Differences in uptake between abnormal and healthy tissues are noted



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## ORAL or RECTAL CONTRAST AGENTS

Compounds that are categorized as either iodinated or barium sulfate taken orally or rectally

(agent responsible for increased attenuation of x-ray beam)

- Opacifies the gastrointestinal tract
- Reduces chance of misdiagnosing air in the bowel as an abscess or fluid in the bowel as a lesion vs. healthy bowel.



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## INTRATHECAL CONTRAST AGENT

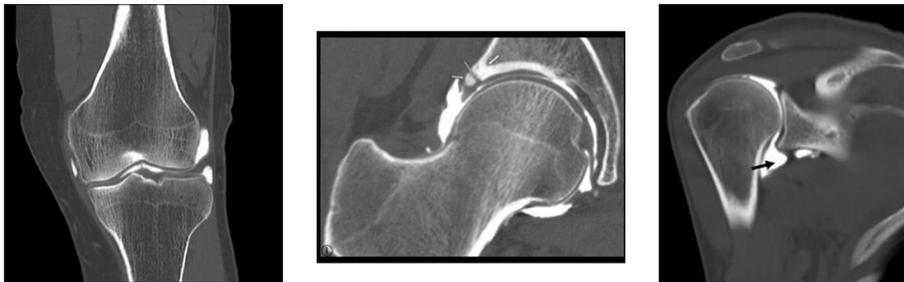
CT exams performed after a myelographic study of the spine to enhance or clarify myelographic findings of intradural and extradural abnormalities.

- 1-4 hours between intrathecal contrast administration and CT – allows time for contrast to dilute
- Patient needs to be rolled periodically to keep the contrast agent and CSF from layering

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## INTRAARTICULAR CONTRAST

- Contrast can be injected directly into a joint space
- CT arthrography
  - Radiologist will inject the contrast under fluoroscopic guidance and then a CT will be performed



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## SAFETY PRECAUTIONS

### Patient Screening

- Ideally should take place prior to the exam day
- Screening issues of interest
  - The reason for the CT scan
  - Potential for pregnancy
  - Patients medical history
    - Asthma
    - Allergies
    - Renal disease , etc
  - Values of the patients lab tests



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