Identifying Image Artifacts, Their Causes and How to Fix Them: PET

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Case 1

Can we scan with a defective block detector?

Daily Quality Assurance Results

- Singles
- Coincidence
- Timing
- Energy
Case 1

Uniform phantom of F-18 in water

Current Day
Defective Block

Previous Day
System Okay

non-TOF

TOF
Case 1

Uniform phantom of F-18 in water

Current Day
Defective Block

Previous Day
System Okay

non-TOF

TOF

SUV: non-TOF

SUV: TOF

WE-G-209-3 Artifacts: PET
Case 1

Uniform phantom of F-18 in water

Current Day
Defective Block

Previous Day
System Okay

non-TOF

TOF

Discussion:
• Artifacts will depend on
  • whether system is PET-only or hybrid
  • number of blocks and their location within scanner
  • activity distribution within the object
• SUVs will be affected
Case 2

Description:
- Streaks throughout reconstructed PET images

N-13 ammonia cardiac PET study

[Images of transaxial and coronal images]
Case 2

Cause:
• Failure of two modules (16 block detectors) during the day

Resolution:
• Reboot system
• Replace hardware

Daily Quality Assurance Results (mid-day)

Transaxial image
Case 3

Description:
- Streaks in coronal PET images
- Large photopenic areas with no apparent uptake
Case 3

PET/CT Fused

PET with CTAC
Case 3

PET/CT Fused  PET with CTAC  PET NAC
Case 3

Cause:
- Patient motion between CT and PET scans
- Activity appears to be outside the body
- Overcorrection of scatter
- There will be errors in attenuation correction too
Case 3

Cause:
- Patient motion between CT and PET scans
- Activity appears to be outside the body
- Overcorrection of scatter
- There will be errors in attenuation correction too

Resolution:
- Do not apply scatter correction
- Limit the scatter correction
Case 4

Description:
• Photopenic areas over diaphragm and dome of liver
Case 4

CT

PET with CTAC
Case 4

CT  PET with CTAC  PET NAC
Case 4

CT

PET with CTAC

PET NAC

PET with CTAC TOF
Case 4

Cause:
• Respiratory motion
• Misregistration of PET and CT at the diaphragm
• Undercorrection of attenuation

Resolution:
• Breathing techniques
• Respiratory gated PET and CT
• Apply TOF
Case 5

Description:
• Reduced blood flow in anterior region of an N-13 ammonia myocardial blood flow study

SA slices: Apex to base

Polar Map
Case 5

Cause:
• Respiratory motion
• Misregistration of the myocardium in PET and CT
• Undercorrection of attenuation

Resolution:
• Re-align CT AC images onto PET images
• Re-reconstruct PET data with re-aligned CT AC images
• Limitations: Rigid body realignment with translations only
• Apply TOF

Original Images
Corrected Images
Case 5

Patient moves between CT and PET

Original images

Corrected images (re-aligned, re-reconstructed with proper attenuation correction)

Z-scores, compared with normals database

Original images

Corrected images (re-aligned, re-reconstructed with proper attenuation correction)

Z-scores, compared with normals database
Case 6

Description:
• Increased uptake in abdomen
Case 6

CT

PET with CTAC
Case 6

CT  PET with CTAC  PET NAC
Case 6

CT

PET with CTAC

PET NAC

PET with CTAC

Contrast Correction

Cause:
• Overcorrection of attenuation due to presence of contrast

Resolution:
• Apply bilinear HU \( \mu \) conversion with contrast correction
Recommendations

If artifacts are present:

- Investigate the PET data
  - Review sinograms
  - Review PET NAC

- Investigate the attenuation correction data
  - Review AC maps (especially for PET/MR studies)
  - Are PET and AC maps registered?
  - Is contrast media, metal, truncation present?

To reduce artifacts:

- better algorithms
- reduce patient motion
- use TOF whenever possible
References


• Lodge MA, Mhlanga JC, Wahl RL. Effect of patient arm motion in whole-body PET/CT. *J Nucl Med* 2011;52:464P.
