Evaluation of a Deep Learning Image Reconstruction Algorithm for Improved Contrast and Decreased Image Noise in Abdominal CT

AM Salyapongse, MS[1,2]; MG Wagner, PhD[2]; MG Lubner, MD[2]; KL Schluter, RT (T)(CT)[2]; MR Smith, MD, PhD[2]; TP Szczykutowicz, PhD[1,2,3]; MD Taya, MS, MD[2]; A Wentland, MD, PhD[2]; GV Toia, MS, MD[1,2]

[1]Department of Medical Physics, University of Wisconsin – Madison
[2]Department of Radiology, University of Wisconsin – Madison
[3]Department of Biomedical Engineering, University of Wisconsin – Madison

DEPARTMENT OF RADIOLOGY
University of Wisconsin School of Medicine and Public Health

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Background

- Advances in artificial intelligence and deep learning have allowed development of advanced reconstruction algorithms for computed tomography (CT) reconstruction utilizing deep learning:
  - TrueFidelity (GE HealthCare, Waukesha, WI)
  - AiCE (Canon Medical Systems)
  - PixelShine (AlgoMedica)
  - ClariCT.AI (ClariPi)
  - DELTA (United Imaging)
- Precise IQ Engine (PIQE) was originally intended for cardiac applications, but was recently released for abdominal applications [1,2]
  - Trained on ultra-high-resolution data from a detector with 0.25 mm detector elements and an x-ray tube with a small focal spot (0.4x0.5 mm) [2]
  - Reconstruction on a 1024x1024 matrix

Materials & Methods

Study cohort

- 69 patients' data was retrospectively included from contrast-enhanced abdominal/pelvic exams between September and November 2024
- Exclusion criteria:
  - Less than 18 years old
  - Metal implants that could obscure anatomy of interest

CT scanning protocol

Protocol	Patient size AP + LAT	kV	Pitch	Rotation time [s]	Automatic exposure control option
Small/ Medium	<80	Sure kV	0.80	0.75	Sure Exposure Control (60 to 950 mA)
Large	≥80			1.0	

Image reconstruction

- 3 mm axial slices
- 3 reconstruction algorithms (**Figure 5**):
  - AiCE level (L) 1 with a 512x512 matrix
  - PIQE L1 with a 1024x1024 matrix
  - PIQE L2 with a 1024x1024 matrix

Likert scoring

- 4 abdominal radiologists were asked to assess image quality on Likert scales where higher scores indicated better quality
  - Image noise (1-5)
  - Image contrast (1-5)
  - Small structure visibility (1-5)
  - Image sharpness (1-4)
  - Artifacts (1-4)
  - Image preference (1-3)

Quantitative analysis

Circular regions-of-interest placed on tissues of interest (**Figure 1**)
Mean CT number and contrast-to-noise ratio (CNR) were recorded

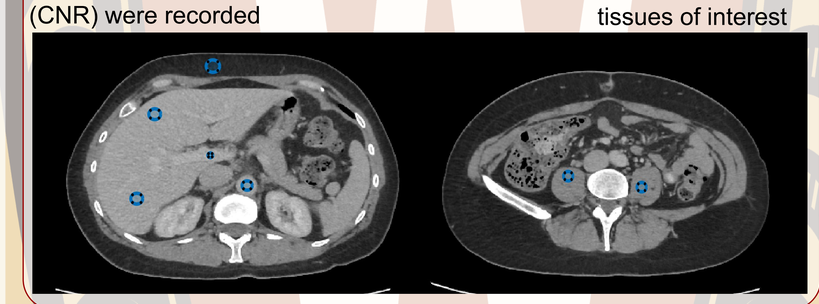


Figure 1: ROI locations for the tissues of interest

Results

Figure 2: Median reader scores for each reconstruction and analysis task

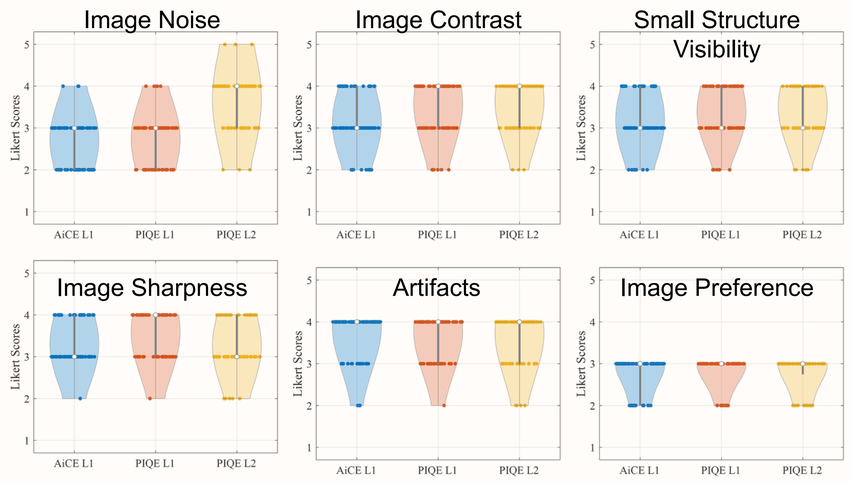
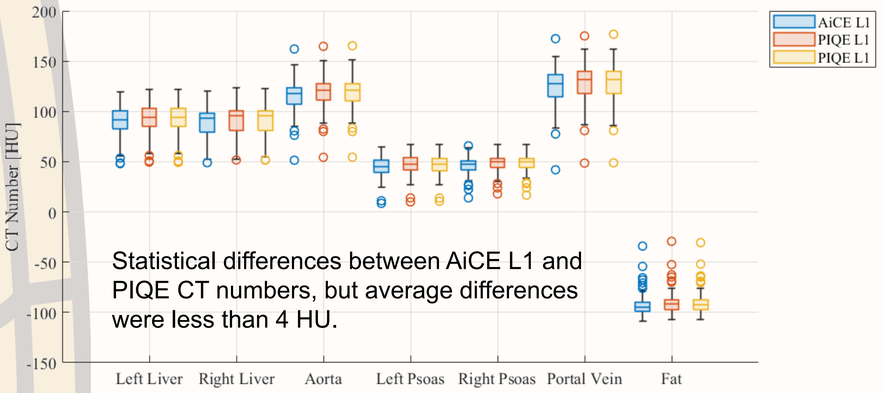


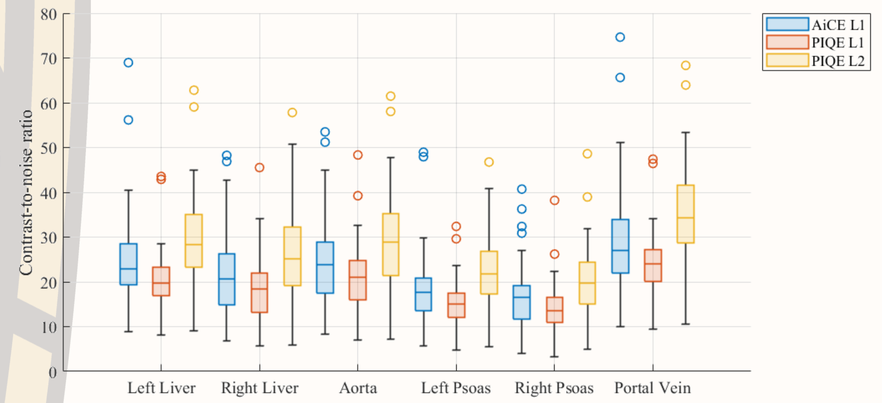
Image noise and image contrast were statistically superior ($p < 0.05$) for PIQE L2 compared to AiCE L1 and PIQE L1 was preferred over AiCE L1 for image contrast. PIQE L1 was preferred over PIQE L2 for image sharpness. No statistical difference was observed for small structure visibility, artifacts, or image preference.

Figure 3: Box plot of the average CT number in the ROI for each subject, each tissue type, and each reconstruction algorithm.



Statistical differences between AiCE L1 and PIQE CT numbers, but average differences were less than 4 HU.

Figure 4: Box plot of the contrast-to-noise ratio in the ROI for each subject, each tissue type, and each reconstruction algorithm.



CNR was statistically significantly higher for AiCE L1 compared to PIQE L1 ($p < 0.0003$) for all tissues. Comparing PIQE L2 to AiCE L1, all comparisons of CNR demonstrated statistically higher CNR in PIQE L2 ($p < 0.00005$).

Key Takeaways

I. Image noise and image contrast were statistically superior in PIQE L2 compared to AiCE L1 in Likert scores
II. PIQE L1 was statistically superior compared to AiCE L1 in Likert scores for image contrast
III. The highest CNR was observed in PIQE L2, then AiCE L1, then PIQE L1

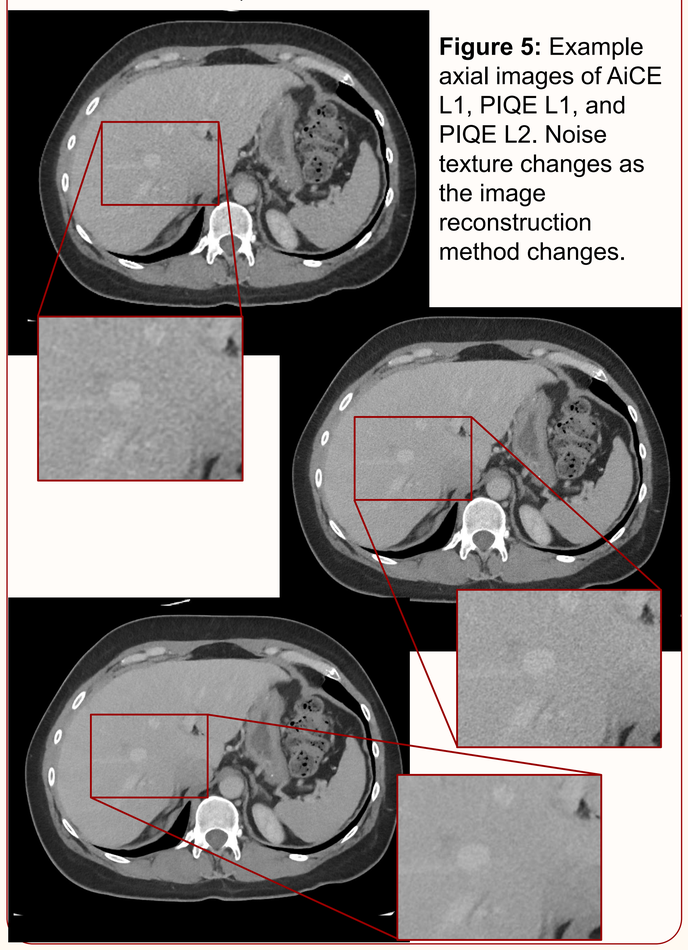


Figure 5: Example axial images of AiCE L1, PIQE L1, and PIQE L2. Noise texture changes as the image reconstruction method changes.

References

[1] Greffier J, Pastor M, Si-Mohamed S, Goutain-Majorel C, Peudon-Balas A, Bensalah MZ, Frandon J, Beregi JP, Dabli D. Comparison of two deep-learning image reconstruction algorithms on cardiac CT images: a phantom study. Diagnostic and Interventional Imaging. 2024 Mar 1;105(3):110-7.
[2] Boedeker K. Precision-trained deep learning: redefining cardiac imaging. Canon Medical Systems Corporation. 2021. URL: https://global.medical.canon/publication/ct/MWPCT0008EA

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