Quantitative Evaluation of AI-Based Denoising (ClariCT.AI): Spatial Resolution and Noise Characteristics

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ABSTRACT

Purpose:
To evaluate a commercial deep learning denoising algorithm (ClariCT.AI) through quantitative phantom measurements and clinical image assessment.

Results:
ClariCT.AI substantially reduced noise magnitude across all dose levels compared to FBP (39% - 49% reduction), achieving lower noise than vendor IR (23% - 36% reduction). NPS analysis revealed that noise texture of FBP+ClariCT.AI was only slightly altered compared to FBP and IR, with the mean frequencies of 2.6 cm^{-1}, 3.1 cm^{-1}, and 2.8 cm^{-1}, respectively. Spatial resolution was preserved with no significant MTFc changes across dose levels (50% difference: 0% - 1.4%; 10% difference: 0% - 3.6%). Clinical images demonstrated markedly reduced liver noise (18% - 61%) with ClariCT.AI processing.

Conclusion:
ClariCT.AI achieves substantial noise reduction (up to 49% in phantom, 61% in clinical images) while preserving spatial resolution and maintaining noise texture characteristics similar to conventional reconstruction methods.

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I. INTRODUCTION

This study evaluated a commercial deep learning denoising algorithm (ClariCT.AI*) through quantitative phantom-based analyses (noise power spectrum and contrast-dependent modulation transfer function) and patient-based clinical validation, focusing on the reduction of noise and preservation of spatial resolution.

*(*ClariPI, claripi.com, Seoul, Republic of Korea)*

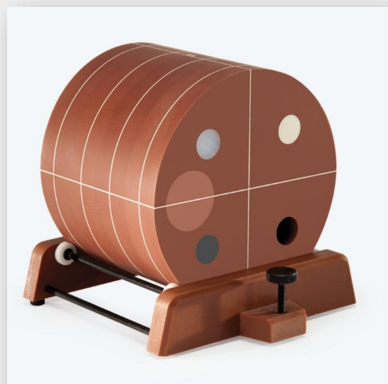
II. MATERIALS AND METHODS

Table 1. CT Scanner and Acquisition Parameters

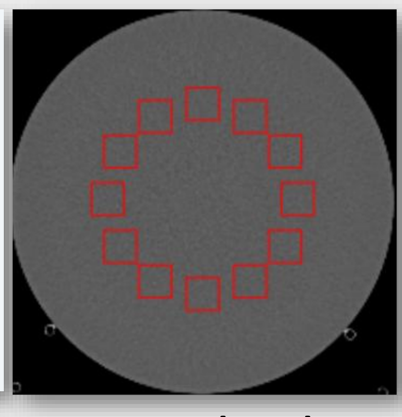
	Description
CT Scanner	GE Revolution EVO CT scanner (GE HealthCare, Chicago, IL)
Protocol	Routine abdomen-pelvis clinical protocol
Tube voltage	120 kVp
Automatic exposure control	Engaged for clinical cases
Reconstruction kernel	Standard abdominal reconstruction kernel
Slice thickness	5 mm

Table 2. Image Processing and Evaluation

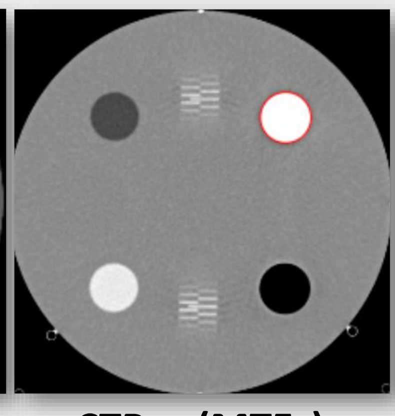
	ACR CT Phantom	Clinical Images
Radiation Doses	50% - 150% of the routine dose level (CTDIvol : 12 mGy)	Routine abdomen-pelvis Protocol (AEC on; CTDIvol: 7.4 - 26.1 mGy)
Image Recon & Processing	FBP, IR, and FBP+ClariCT.AI	FBP, IR, and FBP+ClariCT.AI
Analysis	CTPro (www.ctpro.net)	Radiologist (10 cases)
Evaluation Metrics	✓ Noise magnitude and Noise Power Spectrum (NPS) ✓ Contrast-dependent modulation transfer function (MTFc)	✓ Noise magnitude on subcutaneous fat ✓ Lesion contrast: hepatic lesion vs. adjacent liver parenchyma



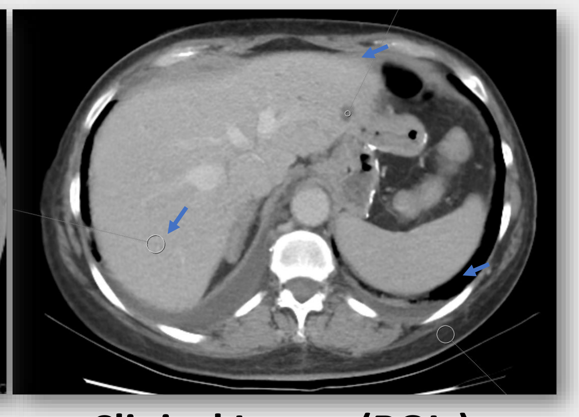
ACR CT Phantom



CTPro (NPS)



CTPro (MTFc)



Clinical Image (ROIs)

III. RESULTS

Noise Power Spectrum in ACR CT Phantom Images

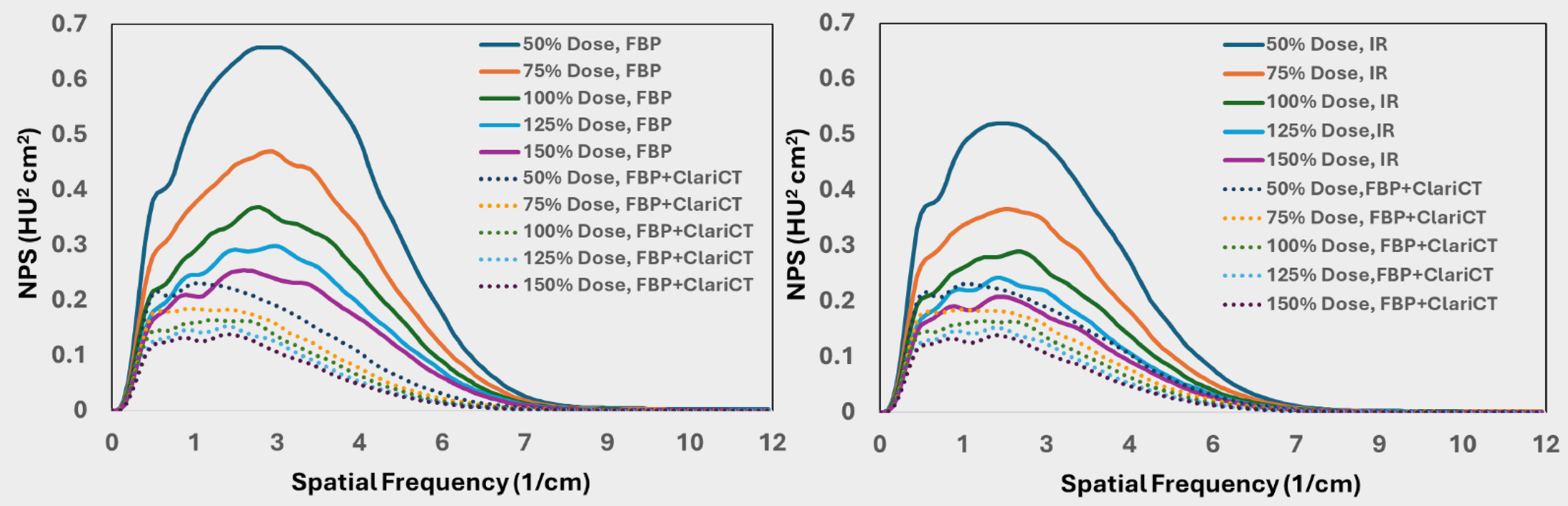


Fig. 1. ClariCT.AI substantially reduced noise magnitude (area under the NPS curve) across all dose levels compared to FBP (left) and vendor iterative reconstruction (IR) algorithm (right). Noise texture (the shape of NPS curve as a function of spatial frequency) was altered relative to FBP but more resembled that of IR.

Modulation Transfer Function in ACR CT Phantom Images

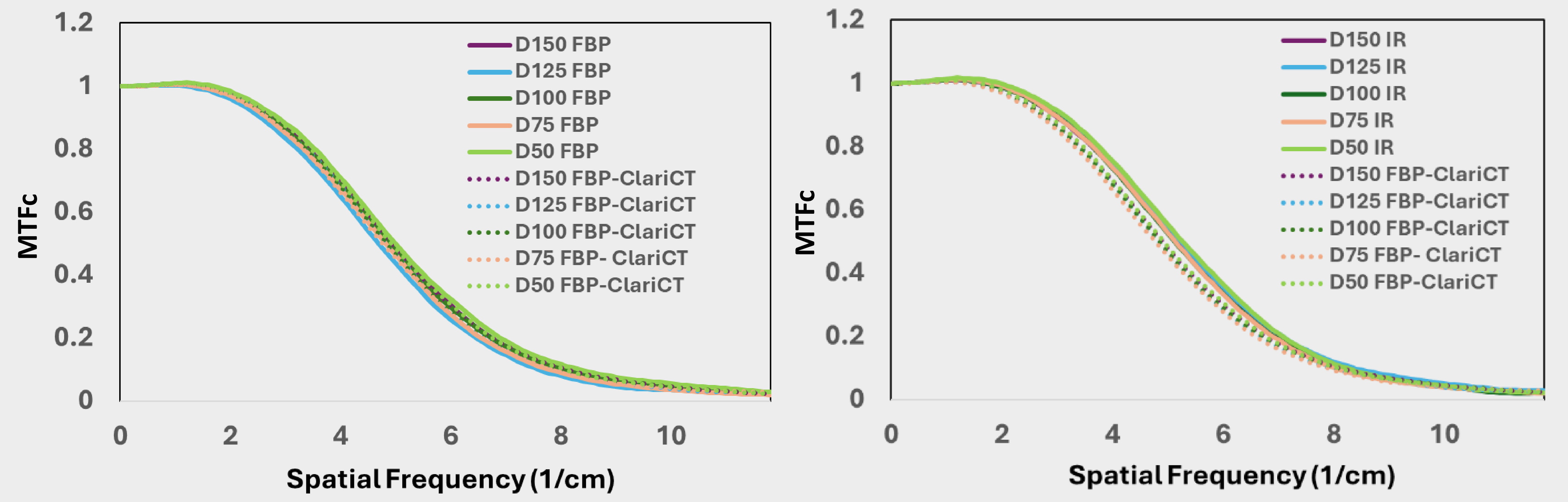
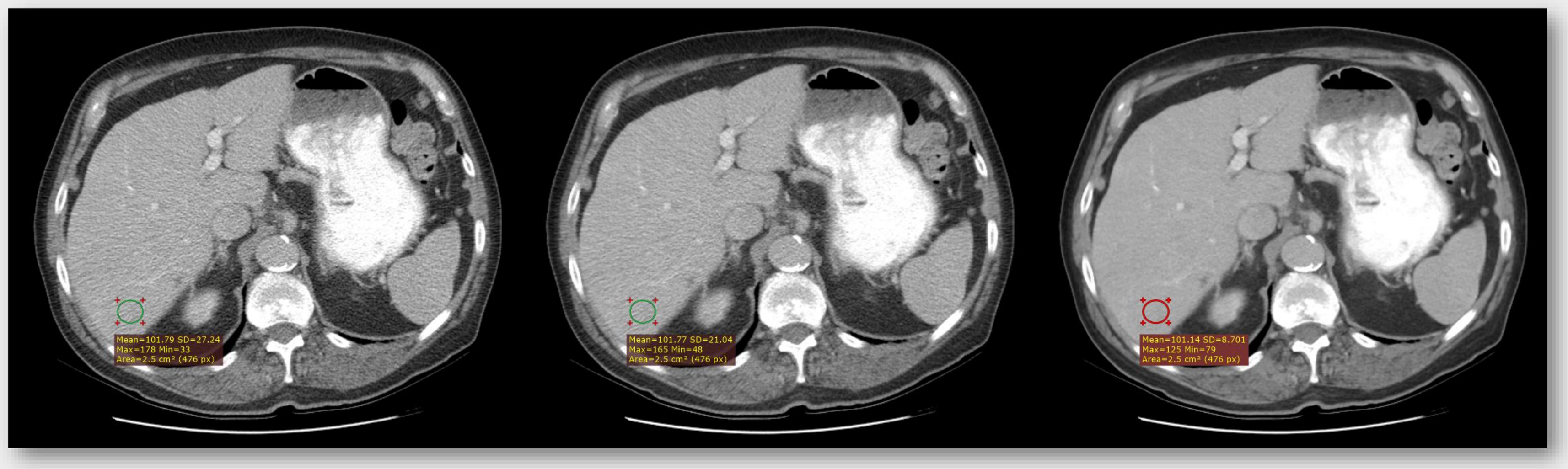


Fig. 2. The contrast-dependent modulation transfer function (MTFc) curves of FBP, IR, and FBP+ClariCT.AI were almost identical, meaning similar spatial resolution. It indicates that ClariCT.AI has capability in preserving fine details of structures as well as providing a finer image texture after denoise processing.

Representative Clinical Images



(a) (b) (c)

Fig. 3. Sample patient images showed markedly improved image quality with ClariCT.AI processing (c), exhibiting clearer boundaries and substantially reduced image noise compared to both FBP (a) and IR (b) reconstructions.

IV. CONCLUSIONS

- **ClariCT.AI achieved noise reduction superior to vendor iterative reconstruction while preserving spatial resolution and maintaining low-contrast detectability.**
- **The patient example showed markedly improved delineation of boundaries and reduced image noise on ClariCT.AI–processed images compared with both FBP and IR.**
- **Performance of the ClariCT.AI–processed images remained consistent across a 3.5-fold dose range (7.4 - 26.1 mGy), establishing predictable lesion conspicuity enhancement for routine clinical integration.**

REFERENCES

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- Sadia, et al., CT image denoising methods for image quality improvement and radiation dose reduction. *J of Applied Clinical Medical Physics*, 2023.