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Comparison of image quality of abdominal CT examinations and virtual noncontrast images between photon-counting and energy-integrating detector CT

Author Block: Ludovica Lofino, MD; Fides Schwartz, MD; Francesco Ria, DMP; Mojtaba Zarei, MSc; Ehsan Samei, PhD; Andres Abadia, PhD; Daniele Marin, MD

Abstract:

***Purpose:** To compare image quality of portal venous phase (PVP) abdominal CT examinations and virtual non-contrast (VNC) images between photon-counting CT (PCCT) and energy-integrating Detector CT (EID).

***Methods and Materials:** In this HIPAA compliant, IRB-approved, retrospective study, multi-phase CT scans from one commercially available PCCT (NAEOTOM Alpha, Siemens Healthineers) and two EID dual-source dual-energy CT systems (SOMATOM Definition Flash and SOMATOM Force, Siemens Healthineers) were retrieved. A total of 45 BMI-matched patients (21 women, 24 men; mean age 58.5 ± 15.3 years, range 19-81 years; mean BMI 29.0 ± 6.8 kg/m², range 13-47 kg/m²) were included: 15 for PCCT and 15 for each EID system. *In vivo* image quality parameters (MTF₁₀, noise magnitude, Fav, F_{peak}, NPS_{f10}) were measured and compared between PCCT and EID for standard PVP and VNC images. A subset analysis was also performed in the overweight patient population (BMI > 25 kg/m²). CTDI_{vol} values were recorded for the three scanners. Because scanner tube current modulation adapts to patient size, radiation dose was compared among scanners accounting for BMI using a figure of merit: $FOM = 1 / (BMI * \ln CTDI_{vol})$.

A five-point scale (1=best and 5=worst) was used to assess reader perception of noise, visibility of small structures, and overall image quality.

***Results:** Compared to the two EID systems, PCCT yielded significantly improved resolution and noise magnitude for both PVP (MTF₁₀ = 0.55 ± 0.08 for PCCT vs. 0.50 ± 0.04 and 0.49 ± 0.03 for Flash and Force, $P=0.02$; noise = 9.76 ± 3.10 vs. 15.35 ± 4.14 and 10.70 ± 1.34 , $P=0.02$) and VNC images (MTF₁₀ = 0.56 ± 0.01 for PCCT vs. 0.51 ± 0.05 and 0.51 ± 0.03 for Flash and Force, $P=0.02$; noise = 9.59 ± 2.77 vs. 13.90 ± 3.57 and 10.83 ± 2.83 , $P=0.02$). A similar statistically significant trend was confirmed in the smaller subset of overweight patients. Our FOM analysis suggests that, for equal radiation exposure levels and comparable patient size, PCCT yields 20% noise reduction compared to the two EID systems, with 18% reduction in overweight patients.

Reader's perceived image noise was significantly lower for PCCT compared to EID for both PVP (1.85 ± 0.88 vs. 2.60 ± 0.88 and 2.70 ± 0.80) and VNC images (1.95 ± 0.83 vs. 3.0 ± 0.97 and 2.90 ± 0.85). Of note, overall image quality improved significantly for PCCT compared to EID (1.35 ± 0.67 vs. 2.60 ± 0.82 and 2.45 ± 0.69 for PVP and 1.50 ± 0.67 vs. 2.85 ± 0.81 and 2.55 ± 0.60 for VNC).

***Conclusions:** Compared to conventional EID systems, PCCT yields significantly lower radiation dose along with improved image quality on PVP and VNC images of abdominal CT examinations.

***Clinical Relevance/Application:** PCCT has a lower radiation dose compared to EID CT, with better image quality parameters and lower noise magnitude.

Category (Complete): Gastrointestinal Imaging -> GICTDR - CT Techniques and Dose Reduction

Format Preference (Complete): Oral Paper

Questions (Complete):

Trainee Research Prize: Resident/Physics Trainee

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IRB / IACUC Response: Human subject, and received IRB approval

Has this work been previously presented or published?: No

2nd Format Opportunity: No, I am not interested in presenting in a second format.

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