Photon Counting Detector CT May Offer More Definitive Images in Difficult Cases

Michael McNitt-Gray, PhD, DABR, FAAPM, FACR
Professor of Radiology
Director, Physics and Biology in Medicine Graduate Program
Department of Radiological Sciences
David Geffen School of Medicine at UCLA

A new development in CT imaging technology has the potential to better discriminate between different tissues being imaged while offering increased spatial resolution. It could prove extremely valuable in the clinical setting, particularly in cases where current CT technology fails to provide definitive images, and could prove to be a significant boon in research applications as well.

Conventional CT detectors — also called energy-integrating detectors — rely on a two-step conversion of incoming X-ray photons to construct images. When X-ray photons reach the detector, they are first converted to photons of visible light in a process called scintillation. These visible light photons then strike the photo diode and are converted to electrical signals. An anti-scatter grid constrains the incoming visible light photons to the areas of the detector that correspond to the locations of the incoming X-ray photons, but decreases the efficiency of the detector. The gridlines don't absorb light photons, so some information is lost.

The new CT technology — called photon-counting detectors or PCD-CT — eliminates the scintillation step, instead directly converting incoming X-ray photons into electrical signals. "You can more accurately locate where the X-ray photon interacts than you could before, and that gives better spatial resolution, which translates to more fine detail in images," explains Michael McNitt-Gray, PhD, professor of radiology. "You can locate more specifically and accurately where each photon interacts."

In addition to recording each photon strike without the intermediary of scintillation, the new CT technology records the energy of each X-ray photon. This additional information about the incoming X-ray photons can reveal more information about the tissue through which the photons have passed. By applying different energy thresholds to the resulting image, radiologists will be able to discriminate between different types of tissue — or tissue and contrast agents — more accurately than conventional CT imaging is able to. "By selecting specific energy thresholds, it's possible to make educated guesses about the kind of tissue the X-ray has passed through," notes Dr. McNitt-Gray. "For example, the technology can help discriminate between bone and iodine contrast based on how the X-rays are absorbed at different energy thresholds."

The ability to constrain images by energy threshold also makes it possible to eliminate low-energy noise coming from the detector. Because of its ability to eliminate background noise, PCD-CT may prove more capable than conventional CT systems in low-dose imaging. In these applications, the relatively fewer X-ray photons will not be obscured by detector noise as can be the case with conventional CT. Indications are that the new technology will at worst be radiation-dose neutral.

In addition to its potential for bringing greater clarity to clinical imaging, PCD-CT's richer information yield could prove to be an important new tool for researchers. "The implications for machine learning / AI, for example, are very interesting to contemplate," says Dr. McNitt-Gray. The additional resolution and energy-level information may result in AI algorithms that are better able to interpret imaging data. "For AI, this represents a change at the front end of the imaging chain. We've been trying to do AI with the same technology for a long time — to be able to add increased information at the very place we interact with the patient, that's pretty exciting."

The new PCD-CT scanner recently received FDA clearance for clinical use in what they called the "first new major technological improvement for computed tomography imaging in nearly a decade." UCLA currently intends to acquire a PCD-CT scanner in about a year. Plans are for it to be initially available in one of UCLA Radiology's outpatient clinics. R

FACULTY AWARDS & RECOGNITIONS

Kathleen Ruchalski, MD

Kathleen Ruchalski, MD, was selected to participate in the 2021-2022 FDA-AACR Oncology Educational Fellowship by the American Association for Cancer Research (AACR). The fellowship focuses on oncology drug development and the regulatory review process.

Shabnam Mortazavi, MD

William Hsu, PhD

Shabnam Mortazavi, MD, and William Hsu, PhD, received an intramural award from UCLA Jonsson Comprehensive Cancer Center for research focused on mapping breast MR and histopathology in breast conserving surgery.