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CARDIOVASCULAR IMAGING

COMMENTARY

Revolutionizing cardiac imaging: how photon-counting computed tomography is redefining coronary artery stent assessment

Çağdaş Topel[1]
Furkan Ufuk[2]

[1]Northwestern University, McGaw Medical Center, Department of Radiology, Chicago, USA

[2]The University of Chicago, Department of Radiology, Chicago, USA

Corresponding author: Çağdaş Topel

E-mail: cagdas.topel@northwestern.edu

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Photon-counting computed tomography (PCCT) represents a groundbreaking advancement in medical imaging, offering unprecedented improvements in spatial resolution, contrast enhancement, and artifact reduction compared with conventional energy-integrating detector (EID) CT scanners.[1] Unlike traditional EID CT, which integrates energy from multiple X-ray photons, PCCT detects and classifies individual photons based on their energy levels.[2] This capability enables superior tissue differentiation, reduced image noise, and substantially enhanced image clarity—critical advantages in cardiovascular imaging, where precise visualization of coronary arteries and stents is essential for accurate diagnosis and treatment planning.[1,2]

Coronary artery disease remains a leading global cause of morbidity and mortality. Accurate assessment of coronary anatomy, particularly in patients with percutaneous coronary interventions and stent placement, is crucial for evaluating treatment efficacy and disease progression.[1-3] While coronary CT angiography (CCTA) is a widely adopted non-invasive imaging technique for this purpose, its accuracy is often compromised by artifacts, most notably, blooming effects that obscure stent lumens, particularly in small-diameter stents.[3] PCCT overcomes these limitations by offering ultra-high-resolution (UHR) imaging, which sharpens stent visualization and enhances the precision of non-invasive assessments.[3,4]

Recent research by Stein et al.[5] highlights the transformative potential of PCCT in stent evaluation. Their study, which assessed the performance of dual-source PCCT in imaging small coronary stents using different acquisition modes in a controlled phantom model, revealed striking results. The UHR mode, featuring an ultra-thin 0.2 mm collimation, achieved a median image quality score of 4.0 [interquartile range (IQR): 3.67–4.00], with 37.5% of cases rated as "excellent." In contrast, the high-pitch mode performed substantially worse, yielding a median score of 2.0 (IQR: 1–3) and proving non-diagnostic in 6.3% of cases.[5] These findings underscore the unparalleled ability of UHR PCCT to delineate stent boundaries, minimize blooming artifacts, and provide diagnostic confidence comparable to invasive angiography.

Current CCTA guidelines limit its application to stents ≥3 mm due to the resolution constraints of conventional CT.[6] Metallic struts in smaller stents often produce pronounced blooming artifacts, obscuring the lumen and reducing diagnostic reliability.[3,4,6] However, recent studies suggest that PCCT may redefine these standards.[5,7,8] In a study by Hagar et al.[7], UHR PCCT demonstrated high diagnostic performance in 44 coronary stents, achieving a sensitivity of 100%, specificity above 87%, and an inter-reader agreement of 90.1%. Similarly, Qin et al.[8] assessed 131 stents and found that UHR images substantially improved in-stent lumen visualization compared with standard-resolution images, with UHR achieving an accuracy of 88.0% compared with 78.3% for standard resolution. Moreover, future advancements in PCCT hardware, including next-generation detectors with <0.1 mm spatial resolution, are expected to further refine its ability to visualize stent strut thickness and detect microcalcifications with unmatched precision.

Despite these promising developments, challenges remain. Motion artifacts in patients with arrhythmias can affect image quality, and global access to PCCT technology is limited, with fewer than 5% of imaging centers currently equipped with this advanced modality.[9]

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In conclusion, PCCT is poised to revolutionize cardiac imaging by surpassing the 3 mm imaging barrier, enhancing tissue characterization, and integrating AI-driven automation into diagnostic workflows. As imaging guidelines evolve and costs decline, PCCT has the potential to democratize high-precision cardiovascular imaging, making state-of-the-art diagnostics more widely accessible. The future of cardiology is becoming less invasive—driven by insight, innovation, and the transformative potential of photon-counting technology.

Conflict of interest disclosure

The author declared no conflicts of interest.

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