Diagn Interv Radiol 2025; DOI: 10.4274/dir.2025.253274

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

Received 5 February 2025; accepted 25 February 2025.

Epub: 26.03.2025

Publication date: 08.07.2025

DOI: 10.4274/dir.2025.253274

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]

You may cite this article as: Topel Ç, Ufuk F. Revolutionizing cardiac imaging: how photon-counting computed tomography is redefining coronary artery stent assessment. *Diagn Interv Radiol.* 2025;31(4):340-341.

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

Furkan Ufuk, MD, is Section Editor in Diagnostic and Interventional Radiology. He had no involvement in the peer-review of this article and had no access to information regarding its peer-review. Other authors have nothing to disclose.

References

1. Meloni A, Maffei E, Positano V, et al. Technical principles, benefits, challenges, and applications of photon counting computed tomography in coronary imaging: a narrative review. Cardiovasc Diagn Ther. 2024;14(4):698-724. [CrossRef]
2. http://doi.org/10.21037/cdt-24-52 [CrossRef]
3. Sharma SP, Lemmens MDK, Smulders MW, Budde RPJ, Hirsch A, Mihl C. Photon-counting detector computed tomography in cardiac imaging. Neth Heart J. 2024;32(11):405-416. http://doi.org/10.1007/s12471-024-01904-5 [CrossRef]
4. Sharma A, Cerdas MG, Reza-Soltani S, et al. A Review of Photon-Counting Computed Tomography (PCCT) in the Diagnosis of Cardiovascular Diseases. Cureus. 2024;16(11):e73119. Published 2024 Nov 6. http://doi.org/10.7759/cureus.73119 [CrossRef]
5. Fahrni G, Boccalini S, Prieur C, Douek P, Si-Mohamed SA. Comprehensive Imaging of Coronary Stent Using Ultra-High Resolution Spectral Photon Counting CT: A Multimodality Validation. JACC Cardiovasc Interv. 2023;16(19):2466-2468. http://doi.org/10.1016/j.jcin.2023.07.035 [CrossRef]
6. Stein T, Muhlen Cvz, Verloh N et al. Evaluating small coronary stents with dual-source photon-counting computed tomography: effect of different scan modes on image quality and performance in a phantom. Diagn Interv Radiol . 2025 Jan;31(1):29-38. http://doi.org/10.4274/dir.2024.242893 [CrossRef]
7. Narula J, Chandrashekhar Y, Ahmadi A, et al. SCCT 2021 Expert Consensus Document on Coronary Computed Tomographic Angiography: A Report of the Society of Cardiovascular Computed Tomography. J Cardiovasc Comput Tomogr. 2021;15(3):192-217. http://doi.org/10.1016/j.jcct.2020.11.001 [CrossRef]
8. Hagar MT, Soschynski M, Saffar R, et al. Ultra-high-resolution photon-counting detector CT in evaluating coronary stent patency: a comparison to invasive coronary angiography. Eur Radiol. 2024;34(7):4273-4283. http://doi.org/10.1007/s00330-023-10516-3 [CrossRef]
9. Qin L, Zhou S, Dong H, et al. Improvement of coronary stent visualization using ultra-high-resolution photon-counting detector CT. Eur Radiol. 2024;34(10):6568-6577. http://s [CrossRef]