Cardiac CT: The new cornerstone of precision cardiovascular medicine

Marcello Chiocchi[1,*] Simone Steffani[2] and Mario Laudazi[2]

[1]Policlinico Tor Vergata; Viale Oxford, 81 00133 Rome, Italy
[2]University of Rome Tor Vergata, Department of Biomedicine and Prevention, Via Cracovia 50 00133 Rome, Italy

Correspondence: marcello.chiocchi@gmail.com

Published: 25/02/2026

As modern cardiology moves beyond a purely stenosis-centered paradigm and toward an integrated understanding of coronary anatomy, plaque biology, myocardial consequences, and procedure planning, Cardiac CT (CCT) is increasingly positioned as a major platform within precision cardiovascular medicine. In this editorial, we intentionally provide a clinically oriented narrative synthesis (rather than a systematic review) of the current evidence and emerging directions surrounding the "One-Stop Shop" concept [1]. For clarity, we use "One-Stop Shop" in an operational sense to describe a coordinated CCT-based diagnostic strategy that may combine anatomic assessment with selected complementary functional and tissue-level information, while recognizing that not every component is necessary, available, or validated in every patient or center. Within this bounded framing, CCT is now firmly established as a central non-invasive modality for defining coronary anatomy and for excluding obstructive coronary artery disease in appropriately selected patients, with high negative predictive value that has materially changed diagnostic pathways in contemporary care [2]. Moving beyond luminal stenosis alone, contemporary CCTA can also characterize atherosclerotic plaque burden and morphology with increasing detail, extending risk assessment beyond calcium scoring toward qualitative and quantitative plaque analysis [3]. Features such as low-attenuation plaque, positive remodeling, and the napkin-ring sign are associated with higher-risk phenotypes in appropriately studied populations, but their interpretation depends on acquisition quality, reader expertise, and clinical context [1, 3].

Accordingly, plaque phenotyping should be viewed as a tool for integrated risk stratification and preventive decision support rather than as an isolated determinant of management, and claims regarding vulnerability should remain aligned with the evidence level and patient population under study [1, 3]. Functional assessment derived from CCTA data further extends the clinical utility of CCT when anatomic stenosis severity alone is insufficient to define lesion significance. FFR-CT (Fractional Flow Reserve derived from CT) uses computational modeling applied to standard CCTA datasets to estimate lesion-specific ischemic relevance and has shown meaningful diagnostic agreement with invasive FFR in selected populations [4]. In practice, this can improve triage by helping distinguish hemodynamically relevant stenoses from bystander disease and may increase the efficiency of referral for invasive angiography and revascularization when embedded in an appropriate workflow [4]. At the same time, rigorous interpretation requires acknowledgment of key assumptions and practical constraints, including adequate image quality, method-specific computational pipelines, variable performance across lesion complexity, and dependence on local access and turnaround time; importantly, when FFR-CT is derived from an already acquired standard CCTA dataset, the computational analysis itself does not add radiation exposure, although the overall imaging strategy still requires patient-specific risk-benefit justification [4].

Stress CT perfusion (CTP) can add a complementary functional layer in complex or equivocal cases where anatomic findings and ischemic relevance do not align cleanly [1]. By evaluating myocardial enhancement under stress conditions, CTP may improve detection of physiologically significant disease and can be particularly helpful in selected patients with multivessel disease, severe calcification, prior revascularization, or suspected microvascular dysfunction [1]. However, claims of broad equivalence with CMR or PET should be stated cautiously because diagnostic performance depends on protocol design (static versus dynamic), scanner platform, stress agent, reconstruction method, reference standard, and local expertise; therefore, the most defensible conclusion is that CTP strengthens functional assessment in selected patients and experienced centers rather than universally replacing established modalities [1].

Artificial intelligence (AI), including deep learning methods, is one of the most promising developments in CCT, but claims should be stated with technical specificity and evidentiary restraint [5]. AI-enabled tools can support segmentation, stenosis quantification, plaque analysis, and workflow standardization, and current reports suggest improved reproducibility and, in some contexts, stronger agreement with reference standards than routine manual interpretation alone, while still requiring expert oversight and quality control [5]. The frequently used phrase "virtual biopsy" is best interpreted as a metaphor for advanced image-based phenotyping rather than literal histopathologic equivalence; in this context, recent quantitative plaque analyses and registry-scale observations, including CONFIRM2, support the clinical relevance of multidimensional plaque burden metrics and AI-assisted quantification for risk stratification, while prospective implementation and outcome-impact studies remain important next steps [3]. Radiomics adds another layer by extracting high-dimensional descriptors that may refine prognostic models, but translation into practice depends on harmonized acquisition, feature stability, reproducibility testing, external validation, and transparent reporting [6]. Within this broader framework, markers such as epicardial adipose tissue [7] and body composition metrics [8] should be framed as potentially useful adjuncts within integrated risk assessment rather than standalone determinants of prognosis.

On the hardware front, photon-counting CT and advanced dual-source geometries represent important technical advances with clear implications for image quality and expanding clinical applicability [9]. Improvements in spatial resolution and spectral performance can reduce blooming artifacts and improve confidence in the evaluation of heavily calcified segments and coronary stents, although performance remains dependent on platform, protocol, and case complexity [9]. Improved temporal resolution may also support diagnostically useful imaging in patients with higher heart rates or rhythm irregularity, but the strength of evidence varies across indications and includes phantom-based data that should not be overgeneralized to all clinical settings without qualification [10]. In parallel, protocol innovation has enhanced safety and strengthened the feasibility of serial imaging in clinically justified scenarios [11]. Iterative reconstruction, spectral shaping, and protocol optimization can meaningfully reduce radiation dose while preserving diagnostic utility in many indications, but dose claims should always be interpreted in relation to scanner generation, patient size, heart rate, image quality endpoints, and the specific diagnostic task [11, 12]. Accordingly, surveillance applications, including post-stent assessment and selected longitudinal imaging strategies, should be individualized according to indication, expected clinical benefit, and the capabilities and limitations of the available scanner and protocol [9].

Although the "comprehensive hub" concept is often discussed in chronic coronary disease, the same integrative logic can be valuable in selected acute-care pathways when applied with appropriate triage discipline [1]. For selected patients with acute chest pain, CCTA-based strategies can accelerate risk stratification and support timely management decisions [13]. Triple Rule-Out (TRO) protocols may be helpful in carefully chosen cases of undifferentiated chest pain when simultaneous evaluation of the coronary arteries, pulmonary arteries, and thoracic aorta is clinically justified and logistically feasible, but TRO should not be portrayed as a universal solution because patient selection, contrast timing, scanner capability, local expertise, and radiation considerations remain central to appropriate use [13]. The emergency imaging literature and illustrative reports, including case-based examples such as pregnancy-related spontaneous coronary artery dissection, demonstrate the breadth of CT applications but should be interpreted according to evidence level when extrapolating to routine pathway design [13, 14].

CCT is also increasingly valuable for procedural planning and image-guided intervention. Pre-procedural CT can characterize lesion length, vessel caliber, calcific distribution, and three-dimensional geometry in ways that inform strategy for complex percutaneous coronary intervention, particularly in anatomically challenging lesions [15]. Fusion of CT datasets with fluoroscopy or other intra-procedural imaging modalities is promising for improving spatial orientation and planning precision, but the magnitude of benefit is procedure-dependent and influenced by workflow integration, software capability, and operator experience [15]. Beyond the coronary tree, CCT has become integral to pre-procedural planning for structural heart interventions, including transcatheter replacement procedures for aortic and other valves, where precise annular and surrounding anatomic assessment is essential [16]. In this setting, multimodality fusion approaches, including combinations with advanced echocardiographic imaging, are particularly promising for complex interventions, while standardization and comparative validation remain active areas of development [17].

Finally, myocardial tissue characterization with Dual-Energy CT (DECT), including iodine mapping and late iodine enhancement approaches, represents an important frontier because it expands CCT from predominantly vascular imaging toward myocardial phenotyping. Emerging evidence suggests clinically meaningful potential for extracellular volume estimation and scar/fibrosis assessment in selected settings, but performance estimates depend on acquisition timing, reconstruction choices, patient characteristics, and comparator methodology, and should therefore be reported and interpreted with careful methodological qualification [18, 19]. Taken together, the evidence cited in this editorial supports a strong but deliberately bounded conclusion: CCT has evolved from a primarily anatomic gatekeeping test into a multi-component imaging platform that can integrate coronary anatomy, plaque phenotype, computational physiology, selected perfusion assessment, procedural planning, and emerging myocardial tissue characterization within coordinated clinical pathways. Whether and to what extent this becomes a true "One-Stop Shop" in routine practice will depend on infrastructure, protocol quality, training, software availability, reimbursement, and continued prospective validation demonstrating incremental patient-centered benefit beyond existing strategies.

Clinical trial number

Not applicable.

Informed consent

Informed consent was obtained from the participants.

Financial disclosure

The authors have not provided financial support.

Conflict of interest

No conflicts of interest were declared by the authors.

References

[1] Serruys, Patrick W., et al. "Coronary computed tomographic angiography for complete assessment of coronary artery disease: JACC state-of-the-art review." Journal of the American College of Cardiology 78.7 (2021): 713-736.

[2] Vrints, Christiaan, et al. "2024 ESC guidelines for the management of chronic coronary syndromes: developed by the task force for the management of chronic coronary syndromes of the European Society of Cardiology (ESC) endorsed by the European Association for Cardio-Thoracic Surgery (EACTS)." European Heart Journal 45.36 (2024): 3415-3537.

[3] Feuchtner, Gudrun M., et al. "AI-quantitative CT coronary plaque features associate with a higher relative risk in women: CONFIRM2 registry." Circulation: Cardiovascular Imaging 18.6 (2025): e018235.

[4] Li, Changling, et al. "Diagnostic performance of fractional flow reserve derived from coronary CT angiography: the ACCURATE-CT study." JACC: Cardiovascular Interventions 17.17 (2024): 1980-1992.

[5] Bernardo, Rachel, et al. "Diagnostic accuracy in coronary CT angiography analysis: artificial intelligence versus human assessment." Open Heart 12.1 (2025): e003115.

[6] Cavallo, Armando Ugo, et al. "CT and MRI radiomics in cardiovascular risk prediction: a systematic review and meta-analysis by the EuSoMII Radiomics Auditing Group." European Radiology (2025): 1-12.

[7] Chiocchi, Marcello, et al. "Cardiac computed tomography evaluation of association of left ventricle disfunction and epicardial adipose tissue density in patients with low to intermediate cardiovascular risk." Medicina 59.2 (2023): 232.

[8] Ricci, Francesca, et al. "Beyond the obesity paradox: Analysis of new prognostic factors in transcatheter aortic valve implantation procedure." Journal of Cardiovascular Development and Disease 11.11 (2024): 368.

[9] Topel, Çağdaş, and Furkan Ufuk. "Revolutionizing cardiac imaging: how photon-counting computed tomography is redefining coronary artery stent assessment." Diagnostic and Interventional Radiology 31.4 (2025): 340.

[10] Zsarnoczay, Emese, et al. "Ultra-high resolution photon-counting coronary CT angiography improves coronary stenosis quantification over a wide range of heart rates–A dynamic phantom study." European Journal of Radiology 161 (2023): 110746.

[11] Iatan, Iulia, et al. "Atherosclerotic coronary plaque regression and risk of adverse cardiovascular events: a systematic review and updated meta-regression analysis." JAMA Cardiology 8.10 (2023): 937-945.

[12] Zook, Salma, et al. "Intraindividual comparison of dose reduction and coronary calcium scoring accuracy using kilovolt-independent and tin filtration CT protocols." Radiology: Cardiothoracic Imaging 6.3 (2024): e230246.

[13] Sarto, Gianmarco, et al. "Management of acute chest pain in the Emergency Department: benefits of coronary computed tomography angiography." The International Journal of Cardiovascular Imaging 40.12 (2024): 2447-2457.

[14] Luciano, Alessandra, et al. "The role of cardiac computed tomography in diagnostic and prognostic assessment of pregnancy related spontaneous coronary artery dissection: A case report." Oxford Medical Case Reports 2024.4 (2024): omae030.

[15] Andreini, Daniele, et al. "Pre-procedural planning of coronary revascularization by cardiac computed tomography: An expert consensus document of the Society of Cardiovascular Computed Tomography." Journal of Cardiovascular Computed Tomography 16.6 (2022): 558-572.

[16] Pugliese, Luca, et al. "Role of computed tomography in transcatheter replacement of 'other valves': A comprehensive review of preprocedural imaging." Journal of Cardiovascular Medicine 23.9 (2022): 575-588.

[17] Prandi, Francesca Romana, et al. "Advances in imaging for tricuspid transcatheter edge-to-edge repair: Lessons learned and future perspectives." Journal of Clinical Medicine 12.10 (2023): 3384.

[18] Martuszewski, Adrian, et al. "Clinical significance of extracellular volume of myocardium (ECV) assessed by computed tomography: A systematic review and meta-analysis." Journal of Clinical Medicine 14.6 (2025): 2066.

[19] Gatti, Marco, et al. "Diagnostic accuracy of late iodine enhancement on cardiac CT for myocardial tissue characterization: a systematic review and meta-analysis." European Radiology 35.6 (2025): 3054-3067.