Korean Circ J. 2024 Jul;54(7):395-397
https://doi.org/10.4070/kcj.2024.0139
pISSN 1738-5520·eISSN 1738-5555

Korean Circulation Journal

Editorial

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While Awaiting CT-FFR Era: A Novel Approach to Assess Functionally Significant Stenosis With On-Site CT-FFR

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▸ See the article "Diagnostic Performance of On-Site Automatic Coronary Computed Tomography Angiography-Derived Fractional Flow Reserve" in volume 54 on page 382.

The field of cardiology has undergone a significant transformation with the introduction of coronary computed tomographic angiography (CCTA) as a crucial tool for assessing coronary artery disease.[1] Over a remarkably short period, numerous studies have highlighted CCTA's superior accuracy compared to traditional methods such as treadmill testing, stress echocardiography, and SPECT myocardial perfusion imaging in detecting coronary artery disease exceeding 50%.[2] However, it is important to note that CCTA's correlation with invasive fractional flow reserve (IFFR) is not perfect, leading to higher sensitivity but lower specificity compared to standard modalities. While positron emission tomography (PET) and magnetic resonance imaging stress testing offer similar sensitivity to CCTA, they demonstrate superior specificity.[3] Despite its limitations, CCTA has shown better prognostic value and outcomes, particularly in chest pain patients without established coronary artery disease and current guidelines position CCTA as a first line test in guiding further invasive tests for patients with coronary artery disease (CAD).[4]

Efforts to enhance the specificity of CCTA have led to the development of computational fluid dynamics-based techniques such as computed tomography-derived fractional flow reserve (CT-FFR), aiming to simulate IFFR. CT-FFR, exemplified by HeartFlow CT-FFR, has shown promising results in improving specificity and positive predictive value while maintaining sensitivity. These advancements have influenced treatment strategies and cost-effectiveness by reducing the need for invasive tests. The PLATFORM trial, involving 584 patients with suspected coronary artery disease, compared the CT-FFR-guided strategy to a conservative non-invasive approach. Results indicated a significant reduction of invasive tests by up to 61% with the CT-FFR-guided strategy, without observing differences in clinical outcomes.[5] Incorporating CT-FFR into the evaluation of coronary artery disease has demonstrated improved precision in identifying myocardial ischemia and other coronary artery conditions compared to CCTA alone.

Since then, numerous CT-FFR solutions have entered the market with more advanced technique including machine learning.[6] However, despite their many advantages, widespread clinical implementation of CT-FFR still faces challenges, including the need for further enhancement of the diagnostic accuracy of CT-FFR and transmitting processed CT images to external interpretation centers for analysis, which can impede the efficiency and timeliness

OPEN ACCESS

Received: May 3, 2024
Accepted: May 7, 2024
Published online: May 24, 2024

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Funding
The author received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest
The author has no financial conflicts of interest.

Data Sharing Statement
The data required to reproduce these findings cannot be shared as this is an editorial.

of clinical workflow. Therefore, while CT-FFR holds promise as the most useful non-invasive tool for diagnosing coronary artery disease in the near future, further advancements are necessary to overcome logistical obstacles and facilitate seamless integration into routine clinical practice.

In this issue of the Journal, Hwang et al.[7] validated a newly developed on-site CT-FFR compared with invasive FFR in patients with coronary artery disease who underwent CCTA and invasive coronary angiography. The research aims to address the limitations of traditional CT-FFR computation methods by introducing a novel, simpler on-site approach. A total of 319 patients from five tertiary cardiovascular centers in Korea were included in the study. The authors found that the diagnostic accuracy of on-site CT-FFR was 80.6%, sensitivity of 88.1%, specificity of 75.6%, positive predictive value of 65.9% and negative predictive value of 88.9%, meeting the primary hypothesis for hemodynamically significant CAD prediction. They also found that a moderate correlation between CT-FFR and IFFR ($r=0.637$, $p<0.001$) and a discriminant ability of area under curve (AUC) 0.86 compared with anatomical obstructive stenosis on CCTA (AUC, 0.64). Notably, CT-FFR outperforms CCTA in predicting hemodynamically significant CAD, particularly in patients with mild to moderate stenosis. Compared to the existing on-site machine running solutions with sensitivities and specificities ranging from 75–85% and 65–85%, respectively, the current method yields comparable results.[8-10] Moreover, with a high negative predictive value of 88.9% and only 3.9% exclusion rate of CCTA evaluation due to segmentation image issues, this approach proves promising for clinical utilization, providing hemodynamic insight on anatomic obstruction. Overall, the findings suggest that the automated on-site CT-FFR has the potential to enhance CAD diagnosis and treatment decision-making, offering a promising addition to non-invasive imaging modalities.

Presently, there is a lack of direct comparison clinical data between off-site and on-site CT-FFR techniques. However, the potential advantages of on-site analysis are apparent, particularly if it can ensure accuracy. In this context, the results of this study serve as a compelling evidence of how the adoption of on-site CT-FFR can effectively address these challenges, presenting improvements in the applications of CT-FFR in clinical practice.

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