Coronary Computed Tomography Angiography-Derived Fractional Flow Reserve Assessment: Many Roads to Reach the Same Goal — Reply —

We thank Dr. Baumann et al for their interest in and comments on our recent publication. We agree that a novel CT-based FFR algorithm, developed for time-efficient in-hospital evaluation without data transfer, is an interesting option for non-invasive FFR simulation. As described by Baumann et al, this novel in-hospital CT-based FFR has been demonstrated to have incremental diagnostic value with higher specificity and positive predictive value when compared with cCTA,1,2 with approximately 30 min of processing time by a physician or technologist.

Although HeartFlow FFRCT requires transferring the data to an external core laboratory and approximately 1–4 h of effort, this process guarantees the accuracy of FFR simulation by cCTA based on the analysis performed by experienced dedicated analysts and sophisticated data management. As described in our review, accurate lumen border detection by cCTA is one of the key elements guaranteeing the accuracy of FFR simulation.3 Especially in patients with advanced coronary artery disease (CAD) with severe calcification, it is not easy for inexperienced analysts to accurately segment the lumen boundary. In contrast, HeartFlow’s off-site FFRCT analysis has been recently demonstrated to provide excellent anatomic accuracy against optical coherence tomography (OCT) data in noncalcified and calcified plaques, an important step in maintaining the quality of FFR simulation.4 Another advantage of off-site analysis is the opportunity to leverage artificial intelligence deep machine learning methods. By doing the intensive analysis at a dedicated core laboratory, deep machine learning methods can enable continuous improvement in the accuracy of lumen boundary segmentation. On-site methods do not enable the training of image processing methods because the data does not leave the clinical site. Finally, the work required of the physician to send the data for analysis is only a few minutes, while an on-site system requires additional time and effort at the clinical site (30 min). Finally, as a review article for the *Circulation Journal*, we focused on the HeartFlow FFRCT technology because this has the greatest evidence not only about the accuracy of the simulation but about its clinical impact on CAD diagnosis, cost effectiveness, and the prognosis of CAD patients. As pointed out by Baumann et al, the evidence for on-site CT-FFR calculation is currently limited to several single-center retrospective studies based on limited simple sizes (n=50–110). Large-scale, multicenter studies are needed to demonstrate the accuracy and clinical utility for the diagnosis of CAD.

**References**


Hiromasa Otake, MD, PhD
Division of Cardiovascular Medicine,
Department of Internal Medicine,
Kobe University Graduate School of Medicine, Kobe, Japan

Charles A. Taylor, PhD
HeartFlow, Inc., Redwood City, CA, USA;
Department of Bioengineering,
Stanford University, Stanford, CA, USA

Hitoshi Matsuo, MD, PhD
Department of Cardiology,
Gifu Heart Center, Gifu, Japan

Nobuhiro Tanaka, MD, PhD
Department of Cardiology,
Tokyo Medical University Hachioji Medical Center,
Tokyo, Japan

Takashi Akasaka, MD, PhD
Department of Cardiology,
Wakayama Medical University, Wakayama, Japan