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LETTERS TO THE EDITOR

# Evaluation of myocardial infarction patients after coronary revasculation by dual-phase multi-detector computed tomography: Now and in future

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## Abstract

Multidetector-row computed tomography (MDCT) has become one of the major tools in diagnosing and evaluating patients with coronary artery disease in recent years. In selected patients, MDCT has been shown to provide more reliable accuracy in detection of stent patency than invasive coronary angiography. Chiou *et al* reported a delicate infarcted myocardium at-risk score. According to their results, the MDCT-based myocardium at-risk score had a good correlation with the thallium 201 ST-segment elevation myocardial infarction-based summed difference score ($r$ = 0.841, $P$ < 0.001). They claimed that dual-phase MDCT is useful in detecting different patterns of obstructive lesions and the extent of myocardium at risk. In this commentary, we discuss the current status of the clinical application of MDCT in patients with myocardial infarction in relation to evaluating the myocardial perfusion defect, detecting reversible myocardial ischemia, assessing myocardial viability, estimating target lesion restenosis, and calculating of fractional flow reserve from MDCT.



**Key words:** Coronary artery disease; Fractional flow reserve; Multidetector-row computed tomography; Myocardial infarction

**Core tip:** Chiou *et al* reported that dual-phase multidetector-row computed tomography (MDCT) is useful in detecting different patterns of obstructive lesions and the extent of myocardium at risk. In this commentary, we discuss the current status of the clinical application of MDCT in patients with myocardial infarction in relation to evaluating the myocardial perfusion defect, detecting reversible myocardial ischemia, assessing myocardial viability, estimating target lesion restenosis, and calculating of fractional flow reserve from MDCT.

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## TO THE EDITOR

We have read the recent published article by Chiou *et al*[1] which reported that the dual-phase multidetector-row computed tomography (MDCT) is useful in detecting different patterns of obstructive lesions and the extent of myocardium at risk in patients with ST-segment elevation myocardial infarction (STEMI). We think that this article is interesting and would strongly recommend it to readers.

With its rapid advancement in recent years, MDCT has become one of the major tools in diagnosing and evaluating patients with coronary artery disease. The high negative predictive rate has made MDCT a powerful tool in excluding occlusive coronary lesions in symptomatic patients with low probability of disease[2,3]. In selected patients, MDCT has also been shown to provide more reliable accuracy in detection of stent patency than invasive coronary angiography[4]. Chiou *et al*[1] reported a delicate infarcted myocardium at-risk score. According to their results from 135 ST-segment elevation myocardial infarction (STEMI) patients with recurrent symptoms 9 mo after revascularization and analysis of 1966 segments, the myocardium at-risk score has higher sensitivity, specificity, and positive- and negative-predictive values (98.7%, 76.1%, 87.5%, and 97.2% respectively) than analysis from stress-redistribution thallium-201 SPECT plus invasive coronary angiography. In 124 (91.9%) patients in whom all segments were assessable, the MDCT-based myocardium at-risk score had a good correlation with the SPECT-based summed difference score (SDS) ($r$ = 0.841, $P$ < 0.001). With a cutoff value of 2.68, the area under the receiver operating characteristic curve was 0.874 (95%CI: 0.805-0.942) for the MDCT-based infarcted myocardium at-risk score[1]. Although additional studies with a larger population are required, MDCT-based risk stratification has been shown to be a promising noninvasive tool with good correlation to the current standard for evaluating obstructive lesions and the severity of the myocardium at risk in patients with STEMI who develop recurrent symptoms.

Correct identification of flow-limiting coronary artery stenosis is the cornerstone of interventional treatment in patients with ischemic angina[5]. However, the correlation of morphological severity with myocardial blood flow reduction is low[6].

Functional studies with nuclear myocardial imaging, including SPECT and positron emission tomography, are the current major modalities[7], but attenuation artifacts, high radiation dose and prolonged examination time limit the clinical benefits. Several computed tomography (CT) techniques have been developed to evaluate the myocardial blood supply[5]. During the early phase of contrast medium passage through the myocardium, perfusion defects can be delineated by analysis of reconstruction images based on systolic and diastolic cycles[8,9] and optimal timing of first-pass scans[10]. Dual source CT reduces beam-hardening artifacts significantly by use of monochromatic image handling technology, and further improves the accuracy of myocardial perfusion quantification[11]. Dynamic time phases may be useful in prediction of myocardial perfusion defects[12], which may be related to left ventricular functional recovery in patients with acute myocardial infarction[13]. Injection of adenosine before scanning has also been an well-accepted pharmacological stress method for detecting reversible myocardial ischemia[14].

The other important action during the planning of coronary revascularization is to estimate myocardial viability and predict the possible recovery of ventricular function[15]. Differential contrast enhancement of infarcted myocardial tissue was initially recognized on CT images and was also reported for gadolinium-enhanced cardiac magnetic resonance imaging (MRI). In the normal condition, the iodinated and gadolinium contrast medium distribute through the cardiac extracellular space but are excluded from healthy myocardial cells. After ischemic injury, differences in distribution volume occurring after loss of myocardial membrane integrity enable delayed gadolinium-enhanced MRI to define the periinfarction area of edema and the central core of necrosis[16,17]. In a study of preoperative evaluation before coronary artery bypass surgery, the extent of delayed transmural hyperenhancement in MRI images has been shown to have strong correlation with the recovery of regional ventricular function after 6 mo[18]. In the acute myocardial infarction, delayed-enhancement MRI also provides prediction of recovery of function after successful primary angioplasty by analysis of microvascular obstruction[19]. Assessment of myocardial viability using MDCT has been validated by a number of studies. The detection of periinfarction edema[20] and nonreperfused area[21] in the setting of acute myocardial infarction was shown to have good correlation with MRI imaging and myocardial histological staining. In a recent study, myocardial contrast delayed enhancement of MDCT was shown to be well correlated with nonviable myocardium and a significant independent predictor of clinical outcome[22]. The viability evaluation of myocardium by CT is still under verification. However, CT warrants a future role in this area as it is less time-consuming and patient-limiting than MRI[5].

Recently, a novel method of calculation of fractional flow reserve (FFR) from MDCT has been reported[23]. FFR is the ratio of the mean coronary pressure distal to a stenotic coronary lesion to the mean aortic pressure, as measured during invasive coronary angiography[24]. FFR has been shown to have greater accuracy than exercise electrocardiography, myocardial perfusion scintigraphy, and stress echocardiography in determination of hemodynamically significant stenoses[25]. Advancement of technology has enables calculation of FFR from MDCT without additional imaging, change of MDCT protocols, or pharmacological administration[23,26]. In other words, FFR derived from coronary computed tomography is a noninvasive method for diagnosis of lesion-specific ischemia. From the initial data published to date[19,27], use of noninvasive FFR from MDCT for patients with suspected coronary artery disease improves diagnostic accuracy in comparison with MDCT alone. In a recently published multicenter international study, FFR from MDCT showed a diagnostic accuracy, sensitivity, specificity value of 73%, 90%, and 54%, respectively, on a per-patient basis compared to traditionally invasive FFR[23]. In another study, a good correlation was shown between per-vessel FFR from MDCT and invasive FFR values (Spearman's rank correlation = 0.717, $P$ < 0.0001; Pearson's correlation coefficient = 0.678, $P$ <0.0001)[28]. Calculations of FFRs from MDCT were performed by computational fluid dynamic modeling after semiautomated segmentation of coronary arteries and left ventricular mass. This process currently requires approximately 6 h per case[23]. With further improvement of the computation technology, we believe that the processing time will be much shorter, making it feasible for clinical use in the near future.

Noninvasive identification of the patency of culprit vessels remains a challenging issue in patients of STEMI. We and others have reported that MDCT could accurately and safely identify occluded culprit lesions in patients early after acute myocardial infarction (AMI), which may provide important information to aid in risk stratification[29,30]. In patients with acute coronary syndrome sowing ambiguous ST segment changes on electrocardiogram, MDCT adds diagnostic accuracy and helps to exclude pulmonary embolism, aortic dissection, and other thoracic disease[31]. For patients with complex coronary artery disease who require bypass surgery, the 3D-image reconstruction from MDCT also provides additional details to operators[32]. Furthermore, it has been reported that the myocardial viability assessment derived from MDCT after primary revascularization may help to predict the clinical outcome in patients with AMI[22].

In summary, the evaluation of STEMI patients with recurrence of chest symptoms remains a challenge. Utilization of state-of-the-art MDCT for delayed myocardial enhancement and calculation of infarcted myocardium at-risk score helps therapeutic planning and risk stratification. In the near future, we believe that the FFR obtained from MDCT may also contribute to coronary ischemia assessment.

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