Deep learning analysis of the myocardium in coronary computerized tomography angiography for identification significant coronary artery stenosis

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Obstructive coronary artery disease (CAD) is the leading cause of death in the United States (1). Increasing in awareness, and management has decreased the mortality tremendously (1). Cardiac stress test has been widely used to detect the obstructive CAD, in patients with symptom of cardiac angina. However, due to limited sensitivity, time consuming nature of stress imaging, and the expense, cardiac stress testing is not an ideal test for diagnosing the etiology of chest pain.

Coronary computerized tomographic angiography (CCTA) is increasingly used for the management of chest pain patients (2). Its high negative predictive value helps triage the chest pain patient in emergency room with low to intermediate risk for CAD (3). The patients with high degree of stenosis on CCTA most commonly undergo invasive coronary angiography (ICA). However, if the degree of the stenosis is determined intermediate, there is no conclusion whether further alternative ischemic work ups or invasive angiography is recommended.

Deep learning analysis of the myocardium using CCTA is a novel approach to more accurately determine the significance of the lesion in intermediate stenosis. It was first introduced by Zreik *et al.* (4). This approach was tested further by Hamersvelt *et al.* (5). The authors concluded that the addition of the novel methods to the conventional stenosis evaluation improved the discrimination between significant and insignificant disease in intermediate CAD, (AUC from 0.68 to 0.76). It also improved the specificity from 31.1% to 48.4% (5).

Deep learning analysis is the novel method proposed by the author to determine the significance of the stenosis. However, it is technique/instrument dependent. The imaging and protocol used in this study was slightly different from the study conducted by Zreik *et al.* Therefore, the image quality of myocardium characteristic could be different. The flowchart indication in the study design seemed to be contrary to the clinical practice where the ICA is first performed and thereafter fractional flow reserve (FFR) will be likely pursued if ICA indicating intermediate stenosis. The patients who had CCTA followed by ICA without FFR were not mentioned or included. Furthermore, in the current study included only the patients with CCTA followed by FFR could mean the patients in the study population had persistent or recurrent symptoms or are at higher risk. The cut-off degree of stenosis from ICA for significant disease is higher than the one cited on the current guideline. Therefore, the reasons mentioned above could pose the risk of selection bias where there was higher prevalence of significant CAD in this study. The sensitivity and specificity seemed to be different than the previous studies (2,6). This could reflect the quality of the CCTA, or selection bias in the current study. CCTA has been well known with very high negative predictive value to exclude the probability of having CAD with high negative predictive value of 95–100% (2,3,7). However, the negative predictive value shown in this study was only 70%. This could be due to low prevalence of patients with insignificant CAD. The patient population in the current study seemed to have high burden of CAD with high calcium score of 526 with interquartile range of 782, and this reduce the specificity for detection significant stenosis (2). The patients with a high burden of calcium score or high risk of CAD more than likely to have alternative options for ischemic work ups in the clinical practice.

Deep learning analysis of myocardium is the novel method to evaluate the degree of stenosis in addition to visualization of degree of stenosis on CCTA. Not only investigating luminal narrowing of coronary arteries, but also the subtle change in myocardium resulted from ischemic insult. However, there are limitations for this method to be the preferred testing. The myocardium characteristics depend on the patient characteristic including age, gender, race or other comorbidities. The patient population for deep learning analysis should include healthy or normal subjects, in order to enable the computer system to differentiate between diseased versus healthy heart. The characteristics of the myocardium require standardization for general use. Future research is required for deep learning analysis to be used in the clinical practice.

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Footnote

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