Clinical value of high duke treadmill score with myocardial perfusion SPECT

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Duke treadmill score (DTS) is well recognized as a simple prognostic score in patients with suspected coronary artery disease (CAD).^{1,2} It is positioned as a valid clinical tool when clinicians need to make a decision about the catheterization of patients with suspected CAD. It is calculated as follows, exercise duration (minutes) – (5 × ST-segment deviation (millimeters) – (4 × angina index (0 for no angina, 1 for angina, and 2 for exercise-limiting angina) and categorized as follows, low risk; <.5%/year, intermediate risk; .5% to 5%/year and high risk; >5%/year of cardiovascular events with a 4-year follow-up. Clinically, if patient achieved more than 10-minute duration of exercise without chest pain, 1 mm of ST depression on electrocardiogram (ECG) is permissible in terms of a conservative therapy. Shaw et al documented the incremental diagnostic value of DTS using ROC analysis to predict the presence of significant CAD (≥75% stenosis) or severe CAD (3-vessel CAD or ≥75% left main disease).³ They showed the cardiac event rates for low-, moderate-, and high-risk grouping of DTS, annual cardiac death rates were .6%, 2%, and 7%, respectively, which were close to those in the original DTS. In that manuscript, they mentioned the limited sensitivity and specificity of the treadmill test for the detection of CAD may cause an increase of noninvasive stress imaging.^{3,4} Previously, Hachamovitch et al also reported that stress myocardial perfusion single-photon emission computed

tomography (MPS) adds an incremental prognostic value to DTS for the prediction of hard cardiac events.⁵ However, the expensive medical costs of stress imaging, which may add diagnostic accuracy to DTS, would be prohibitive. Therefore, the concordance and discordance between stress exercise test and noninvasive imaging should be discussed.

A previous report showed that about 55% to 69% of patients with known or suspected CAD were classified as moderate risk by DTS.^{3,6} Basically, the patients categorized as intermediate risk by DTS would be good candidates for stress MPS, the majority of the intermediate risk group may derive the maximum benefit for the differentiation of invasive catheter imaging in accordance with Bayes' theorem.^{7,8} The higher sensitivity and specificity of stress MPS over that of the exercise test may reduce the unnecessary invasive imaging.⁶

The relationship between high DTS and stress MPS was evaluated by Shaikh et al in a small population (N = 13) in 2011. They showed that all the subjects with high DTS had high-risk MPS.⁹ They hypothesized that patients with high DTS can be referred for invasive coronary angiography without functional assessment.⁹ In this issue of the journal, Joao et al investigate the survival analysis in a great number of patients (N = 310) with both high DTS and exercise stress MPS. Nearly one-third of the patients (90/310) with high DTS showed normal MPS and low hard event rates. They found about 1.34%/year of cardiovascular death in the abnormal MPS group vs 0%/year of cardiovascular death in the normal MPS group ($P = .03$). Regarding the combined outcomes including cardiovascular death and myocardial infarction, 3.74%/year in the abnormal MPS group vs 1.1%/year in the normal MPS group were observed ($P = .03$). Those findings suggest that the patients with both high DTS and normal MPS could be managed medically. Therefore, direct coronary angiography in patient with high DTS may prejudice the

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Table 1. Pre-test probability of CAD: symptomatic (ischemic equivalent) patients

Indication	Exercise ECG	Stress MPS
Low pre-test probability of CAD ECG interpretable and able to exercise	Appropriate	Rarely appropriate
Low pre-test probability of CAD ECG uninterpretable or unable to exercise		Appropriate
Intermediate pre-test probability of CAD ECG interpretable and able to exercise	Appropriate	Appropriate
Intermediate pre-test probability of CAD ECG uninterpretable or unable to exercise		Appropriate
High pre-test probability of CAD ECG interpretable and able to exercise	May be appropriate	Appropriate
High pre-test probability of CAD ECG uninterpretable or unable to exercise		Appropriate

Table 2. Prior testing without intervening revascularization

Indication	CCTA	Stress MPS
Abnormal prior exercise ECG test	Appropriate	Appropriate

medical cost-effectiveness. Interestingly, they also reported that the patients with high DTS and normal MPS showed longer exercise duration, higher magnitude of ST depression, and angina symptom. Additionally, it would be unconvincing to exclude some patients with left ventricular hypertrophy from the populations.¹⁰

Recent development of new imaging modalities such as coronary computed tomography angiography (CCTA) may propose more pathophysiological approach to CAD.¹¹ The presence of stenosis, positive remodeling, and low-attenuated plaques in coronary arteries predicts a future acute coronary syndrome.¹² Therefore, multimodality appropriate use criteria (AUC) for the detection and risk assessment of stable ischemic heart disease documented the appropriate use of exercise ECG and other imaging modalities in 2013.¹³ In symptomatic patients, exercise ECG is appropriate or maybe appropriate in low, intermediate, and high pre-test probability of CAD. Stress MPS is always appropriate except for the patients with symptom, low pre-test probability, and interpretable ECG (Table 1). Practically speaking, the patients with abnormal prior exercise ECG, who may be categorized into high DTS are appropriate for both stress MPS and CCTA (Table 2). The association between CAD evaluated by CCTA and DTS was documented by Lin et al.¹⁴ In patients with and without obstructive CAD on CCTA, 59% and 23% of

the patients had abnormal DTS, respectively. The association of the degree of obstructive CAD on CCTA and the duration of exercise was also noted.¹⁴ They concluded that the measurement of plaque on CCTA identifies the patients more likely to show high DTS. CCTA would be useful to clarify the discordance between DTS and non-obstructive CAD. Generally, CCTA and stress MPS are known as a morphological and physiological modalities, respectively.¹⁵ However, recently the physiological usage of CCTA as a physiological modality has been proposed.^{16,17}

Another issue of the stress tests in other countries would be an increasing use of pharmacological stress tests. According to the survey of Japanese circulation society in 2013, the numbers of exercise and vasodilator stress MPS were about 72,500 and 128,000, respectively. In the United States only one-half of the stress myocardial perfusion SPECT (MPS) are performed with pharmacologic agents.¹⁸ Both a manpower shortage for the stress test and a release of regadenoson would create the increasing use of vasodilator stress tests. A convenient pharmacological stress test without the evaluation of DTS would be an additional problem.

In conclusion, nearly one-third of high DTS showed normal MPS with low cardiac event rates. The cost-effectiveness of stress MPS is achieved only in patients who were identified as intermediate-to-high risk by either clinical condition or DTS.⁵

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