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Association Between High-Sensitivity Cardiac Troponin Levels and Myocardial Ischemia During Mental Stress and Conventional Stress

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ABSTRACT

OBJECTIVES This study sought to investigate whether patients with mental stress–induced myocardial ischemia will have high resting and post–mental stress high-sensitivity cardiac troponin I (hs-cTnI).

BACKGROUND Hs-cTnI is a marker of myocardial necrosis, and its elevated levels are associated with adverse outcomes. Hs-cTnI levels may increase with exercise in patients with coronary artery disease. Mental stress–induced myocardial ischemia is also linked to adverse outcomes.

METHODS In this study, 587 patients with stable coronary artery disease underwent technetium Tc 99m sestamibi–single-photon emission tomography myocardial perfusion imaging during mental stress testing using a public speaking task and during conventional (pharmacologic/exercise) stress testing as a control condition. Ischemia was defined as new/worsening impairment in myocardial perfusion using a 17-segment model.

RESULTS The median hs-cTnI resting level was 4.3 (interquartile range [IQR]: 2.9 to 7.3) pg/ml. Overall, 16% and 34.8% of patients developed myocardial ischemia during mental and conventional stress, respectively. Compared with those without ischemia, median resting hs-cTnI levels were higher in patients who developed ischemia either during mental stress (5.9 [IQR: 3.9 to 8.3] vs. 4.1 [IQR: 2.7 to 7.0] pg/ml; $p < 0.001$) or during conventional stress (5.4 [IQR: 3.9 to 9.3] vs. 3.9 [IQR: 2.5 to 6.5] pg/ml; $p < 0.001$). Patients with high hs-cTnI (cutoff of 4.6 pg/ml for men and 3.9 pg/ml for women) had greater odds of developing mental (odds ratio [OR]: 2.4; 95% confidence interval [CI]: 1.5 to 3.9; $p < 0.001$) and conventional (OR: 2.4; 95% CI: 1.7 to 3.4; $p < 0.001$) stress-induced ischemia. Although there was a significant increase in 45-min post-treadmill exercise hs-cTnI levels in those who developed ischemia, there was no significant increase after mental or pharmacological stress test.

CONCLUSIONS In patients with coronary artery disease, myocardial ischemia during either mental stress or conventional stress is associated with higher resting levels of hs-cTnI. This suggests that hs-cTnI elevation is an indicator of chronic ischemic burden experienced during everyday life. Whether elevated hs-cTnI levels are an indicator of adverse prognosis beyond inducible ischemia or whether it is amenable to intervention requires further investigation. (J Am Coll Cardiol Img 2017;■:■–■) © 2017 Published by Elsevier on behalf of the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

CAD = coronary artery disease

CI = confidence interval

CSIMI = conventional stress-induced myocardial ischemia

hs-cTn = high-sensitivity cardiac troponin

hs-cTnI = high-sensitivity cardiac troponin I

IQR = interquartile range

MSIMI = mental stress-induced myocardial ischemia

OR = odds ratio

SPECT = single-photon emission computed tomography

Cardiac troponin is a recognized marker of myocardial injury and it is elevated in several clinical conditions besides myocardial infarction, including myocarditis, severe heart failure, hypertensive crises, and pulmonary embolism (1,2). Development of sensitive assays has enabled determination of hitherto undetectable levels of troponin. Recent reports using high-sensitivity assays indicate that troponin can be released in the setting of myocardial ischemia induced by rapid atrial pacing and exercise, even in the absence of necrosis (2–4). Elevated levels of high-sensitivity cardiac troponin (hs-cTn) in subjects without acute coronary syndromes are also associated with adverse long-term outcomes, and thus it is important to determine the mechanisms underlying these changes (1,5–7).

Psychological stress may precipitate myocardial ischemia. In a laboratory setting, mental stress-induced myocardial ischemia (MSIMI) is associated with adverse cardiovascular outcomes in patients with coronary artery disease (CAD), although the mechanisms of this increased risk remain unknown (8). MSIMI may occur even in the absence of ischemia during physical stress (9). Abnormal vasomotion, depression, platelet reactivity, vitamin D deficiency, inflammation, and metabolic risk factors have been associated with MSIMI, but the exact physiological mechanisms are still unclear (9). Although physical stress has been associated with release of troponin, whether MSIMI will also lead to a similar change remains unknown (3,10). In a large sample of patients with chronic stable CAD, we measured high-sensitivity cardiac troponin I (hs-cTnI) levels at rest and after both conventional and mental stress testing to investigate the effects of ischemia on hs-cTnI levels. We hypothesized that subjects with both forms of ischemia, with mental stress and with conventional stress, will have higher resting and/or post-stress hs-cTnI levels. This may help us understand whether recurrent episodes of myocardial ischemia result in hs-cTn elevation.

METHODS

STUDY SAMPLE. Patients were enrolled into the MIPS (Mental Stress Ischemia Prognosis Study), a prospective study that recruited patients with stable CAD between June 23, 2011 and August 5, 2014 at Emory University–affiliated hospitals. Presence of CAD was defined by an abnormal coronary angiogram demonstrating evidence of atherosclerosis with at least luminal irregularities, documented previous percutaneous or surgical coronary revascularization, documented myocardial infarction, or a positive nuclear stress test. Patients with acute coronary syndrome or decompensated heart failure during the previous 2 months, end-stage renal disease, or unstable psychiatric conditions were excluded. Clinical information including previous CAD events, CAD risk factors, coronary angiography results, and current medications were documented using standardized questionnaires and chart reviews. The research protocol was approved by the institutional review board of our institution and all participants provided informed consent. As described previously (11), patients were tested in the morning after a 12-h fast. Antianginal medications (beta-blockers, calcium-channel blockers, and long-acting nitrates), xanthine derivatives, and caffeine-containing products were withheld for 24 h prior to stress testing (conventional and mental). Current and lifetime diagnosis of major depression and other psychiatric diagnoses were assessed with the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (12). Estimated creatinine clearance was calculated by means of the Chronic Kidney Disease Epidemiology Collaboration equation. Angiographic CAD severity was calculated using the Gensini score for 511 patients with a median time between the angiogram and enrolment of 2.1 years (interquartile range [IQR]: 1.0 to 4.7 years) (11).

MENTAL STRESS PROCEDURE. In a quiet dimly lit, temperature-controlled (21°C to 23°C) room, after a 30-min rest period, vital signs were measured and mental stress was induced by a standardized public speaking task. Briefly, patients were asked to imagine

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