Uncertainty of Myocardial Perfusion Imaging in Chest Pain Risk Stratification

Htoo Kyaw, MD,1,3 Sivacharan Buddhavarapu, MD,1 Joseph Abboud, MD,2 Deepika Misra, MD2,3

1Department of Internal Medicine, The Brooklyn Hospital Center, Brooklyn, NY 2Division of Cardiology, The Brooklyn Hospital Center, New York, NY 3Division of Cardiology, Mount Sinai Beth Israel Hospital Center, New York, NY

Background: Chest pain is a common presenting symptom in the emergency department (ED). Although the diagnostic workup for chest pain is well established, the best time to perform invasive cardiac catheterization in patients with low to moderate risk of coronary artery disease is still unclear, particularly if noninvasive tests such as the electrocardiogram (ECG) and nuclear myocardial perfusion scan show nonsignificant findings.

Case Report: We present the case of a 52-year-old female who presented to the ED with acute-onset chest pain that had started early in the morning while she was sleeping. She had presented to the ED 2 weeks prior with chest pain, but her ECG and transthoracic echocardiogram were normal, and her myocardial perfusion scan revealed no significant perfusion defect, so she was discharged. During her second ED visit, the patient developed an arrhythmia, diagnosed as supraventricular tachycardia, that was rapidly converted to sinus rhythm with one dose of intravenous adenosine. Because of her persistent chest pain and the arrhythmia, she underwent cardiac catheterization that revealed coronary artery disease with 80% middle left anterior descending artery stenosis. Percutaneous coronary intervention was performed, and the patient's symptoms resolved.

Conclusion: Chest pain evaluation is challenging for ED physicians, hospitalists, and cardiologists. Although the nuclear myocardial perfusion scan has excellent sensitivity and specificity in ischemic detection, the clinical examination remains the primary determinant of further management.

Keywords: Acute coronary syndrome, angina pectoris, chest pain, myocardial perfusion imaging

INTRODUCTION

Myocardial ischemia, known as angina pectoris, is characterized by substernal pressure-like chest pain that is exacerbated by stress or exercise and relieved by rest and nitroglycerin. According to the 2011 National Hospital Ambulatory Medical Care Survey, an estimated 7 million patients per year presented to the emergency department (ED) with chest pain only in the United States.1 Per Bhuiya et al, in 2008, approximately 13% of patients presenting with chest pain were found to have acute coronary syndrome (ACS).2 Because cardiac-related chest pain is considered a medical emergency, a careful delineation between cardiac origin and other pathologies is paramount. The risk stratification system is fairly reliable, but a gray zone exists for patients with low to moderate risk of coronary artery disease (CAD) in which the appropriate timing of cardiac catheterization is unclear.

We present the case of a middle-aged female who presented with chest pain 2 weeks after a negative cardiac workup but was found to have left anterior descending (LAD) artery stenosis (80%) on cardiac catheterization.

CASE REPORT

A 52-year-old African American female presented to the ED with sudden-onset chest pain that had started early in the morning while she was sleeping. Her chest pain was located on the left side of her chest and was constant, pressure-like in nature, and 7/10 in intensity. The pain was associated with some nausea but no vomiting and had no alleviating or aggravating factors (ie, exercise or rest). The patient’s medical history was significant for hypertension, diabetes mellitus, dyslipidemia, asthma, and gastritis. Two weeks prior to the current visit, she had presented to another hospital with the same complaints and was admitted. Cardiac workup, including electrocardiogram (ECG) and transthoracic echocardiogram (TTE), was normal. A myocardial perfusion imaging (MPI) study was also normal, and she was discharged home.

The patient reported that she had been able to walk many blocks but recently had only been able to walk 2–3 blocks because of chest tightness. The patient’s family history and social history were unremarkable. Review of systems was otherwise negative. While she was in the ED, the patient developed supraventricular tachycardia with a heart rate of
140 bpm on ECG that was immediately resolved with one dose of intravenous adenosine. Her vital signs were rechecked, and she had a temperature of 98.8°F, blood pressure of 135/73 mmHg, and a pulse rate of 90-100 bpm. Her cardiovascular examination was unremarkable without any murmur, extra heart sounds, or gallops. Repeat ECG showed normal sinus rhythm with a heart rate of 85 bpm. She was placed in an observation unit to rule out ACS. Cardiac troponin I serum levels were sent every 6 hours, and 3 consecutive levels were within normal limits. Her TTE from the previous cardiac workup at the other hospital showed an ejection fraction of 70%. Because the patient had ongoing chest pain, cardiac catheterization was performed to evaluate her coronary anatomy and showed 80% middle LAD coronary artery stenosis with an unstable plaque (Figure 1). Percutaneous coronary intervention (PCI) with drug-eluting stent placement was performed without any complications. Her symptoms resolved after PCI, and she was discharged on day 3. At her 2-week follow-up visit, the patient was asymptomatic, and her exercise performance had gradually improved.

DISCUSSION

The onset of CAD is unpredictable and can be found in any age group, although it is more common in the elderly population. Chest pain of cardiac origin can be classified as stable angina, unstable angina or non–ST-elevation myocardial infarction (MI), and ST-elevation MI. Stable and unstable angina can manifest with chest pain without ST elevation in ECG. Age and sex have a tremendous impact on the incidence of MI, with an estimated incidence of 8.92 per 1,000 person-years among 75- to 84-year-old Caucasian males and 8.03 per 1,000 person-years among Caucasian females of the same age group. African Americans have a higher incidence of MI than Caucasians even with the same cardiovascular risk factors. However, poor control of cardiovascular risk factors, including hypertension, diabetes mellitus, and cigarette smoking, can hasten the disease process and lead to premature onset of CAD.

Atherosclerotic vascular disease usually starts from a steady lipid deposition in the endothelial layer of coronary vessels secondary to hyperlipidemia and endothelial injury, resulting in atherosclerotic plaque. With ongoing lipid accumulation in the presence of an inflammatory or injured process, the plaque will become bigger and the fibrous cap will thin, increasing the risk of plaque rupture in patients with uncontrolled blood pressure and manifesting as ACS.

Diagnosis of ACS can be made by taking a thorough history, performing a physical examination with serial ECGs, and checking cardiac enzyme levels. If the ECG shows ST elevation, emergency coronary revascularization strategy may be indicated, and the patient needs to go to the nearest PCI-capable hospital. For patients with typical or atypical chest pain with no ST changes on ECG, cardiac risk stratification based on the individual’s risk factors will help to determine what modality is best suited for further diagnostic evaluation (Figures 2 and 3). Several scoring methods are available for risk stratification in the subset of patients with negative ECG changes and normal cardiac troponin I. The Thrombolysis in Myocardial Infarction (TIMI) score and the...
HEART (history, ECG, age, risk factors, troponin) score are most commonly used because of their simplicity and ease of calculation. The TIMI score is based on 7 criteria—patient age, CAD risk factors, history of prior CAD, recent aspirin use, frequency of angina, ECG findings, and cardiac markers—and has been studied in randomized trials for chest pain risk stratification. As indicated by the acronym, the HEART score considers chest pain history, ECG changes, patient age, risk factors, and serum troponin level and is principally used in the ED. Patient history is emphasized in the HEART score compared to other risk scoring systems, allowing the clinician to better assess for risk-based symptoms. However, the HEART score could also underrate the severity of disease if the patient presents with atypical symptoms.

Risk for CAD can be stratified by using the TIMI or HEART score: low risk (TIMI 0-1 or HEART 0-3), moderate risk (TIMI 2-3 or HEART 4-6), and high risk (TIMI >3 or HEART 7-10). For the low-risk group (TIMI 0-1 or HEART 0-3), further evaluations are not warranted. Exercise or pharmacologic stress testing can be used for patients with moderate risk (TIMI 2-3 or HEART 4-6), while a diagnostic cardiac catheterization along with intravenous anticoagulation (ie, low molecular weight heparin) is anticipated for patients in the high-risk category (TIMI >3 or HEART 7-10).

Figure 3. Risk assessment and further testing based on pretest probability for CAD in a patient with chest pain. The HEART score includes patient history and age, ECG changes, risk factors, and troponin level. The TIMI score is based on 7 risk factors: patient age ≥65 years, aspirin use in the last 7 days, at least 2 angina episodes within the last 24 hours, ST changes of at least 0.5 mm in contiguous leads, elevated serum cardiac biomarkers, known CAD (coronary stenosis ≥50%), and at least 3 risk factors for CAD. CAD, coronary artery disease; ECG, electrocardiogram; HEART, history, ECG, age, risk factors, troponin; PCI, percutaneous coronary intervention; TIMI, Thrombolysis in Myocardial Infarction.
with chest pain and CAD risk factors (TIMI score of 2 and HEART score of 4). She underwent TTE and MPI according to the risk stratification algorithm (Figure 3), but her tests revealed insignificant findings. Her ongoing chest pain prompted another ED visit during which a diagnostic angiogram showed a significant CAD requiring stent placement.

MPI is used to identify underlying IHD primarily in individuals who cannot perform an exercise stress test or have a contraindication to exercise stress testing. The vasodilatory characteristics of coronary arteries play a pivotal role in comparing relative perfusion differences between an area with normal blood supply and one with decreased perfusion by allowing for these relative perfusion differences to become apparent. Adenosine, dipyridamole, or regadenoson is usually given, while regadenoson-induced single-photon emission computed tomography MPI is a widely used modality in the United States. Adenosine- and dipyridamole-induced MPI have similar reported overall sensitivities of 83%-97% and specificities of 38%-94%. One of the pitfalls of MPI is its inability to detect the variance in patients with multivessel CAD or severe left main and proximal LAD disease because of the global reduction in myocardial blood supply, a condition called balanced ischemia. Given its excellent sensitivity and specificity, clinicians often use MPI as part of their diagnostic strategy to determine the necessity of ICA, but a false-negative MPI can sometimes lead to an inappropriate clinical decision, resulting in a late diagnosis.

Diamond et al reported that of 9,171 stress tests (exercise-, vasodilator-, or dobutamine-induced stress), 3,992 cases were interpreted as normal or near normal. Of these 3,992 patients, 98 patients underwent cardiac catheterization because of clinical suspicion, and 9 patients had severe CAD: left main CAD (3 patients), 3-vessel CAD with or without left main disease (3 patients), and severe proximal LAD CAD (3 patients). A retrospective study by Yokota S et al reported that 93 of 256 patients with a normal MPI, taking a careful history, and performing a physical examination will help guide clinicians to an appropriate clinical decision.

**ACKNOWLEDGMENTS**

The authors have no financial or proprietary interest in the subject matter of this article.

**REFERENCES**


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