MAYO CLINIC

86-Year-Old Man With Sharp Chest Pain and Dyspnea

Nikhil Kolluri, MD; Michael D. Klajda, MD; and Nandan S. Anavekar, MB, BCh

See end of article for correct answers to questions.

Resident in Internal Medicine, Mayo Clinic School of Graduate Medical Education, Rochester, MN (N.K., M.D.K.); Advisor to residents and Consultant in Cardiovascular Diseases, Mayo Clinic, Rochester, MN (N.S.A.).

An 86-year-old man with a history of coronary artery disease after 3-vessel coronary artery bypass grafting (left anterior descending coronary artery, first and second obtuse marginal branches) in 2000, hypertension, and atrial fibrillation with tachycardia-bradycardia syndrome after permanent pacemaker placement in 2015 presented to his physician with new-onset nonexertional sharp chest pain with radiation to his neck for 1 day. His chest pain was associated with diaphoresis and dyspnea. Before his presentation to the hospital, he had taken 5 baby aspirin tablets and called emergency medical services. He was given nitroglycerin with temporary relief of symptoms en route to the hospital. In the setting of ongoing chest pain in the hospital, he was admitted to the cardiac intensive care unit for further management.

Physical examination revealed a temperature of 36.9°C, heart rate of 64 beats/min, blood pressure of 95/75 mm Hg, and oxygen saturation of 93%. He was in no acute distress. Mildly increased jugular venous distention was observed. Cardiac examination revealed a regular rhythm without murmurs, rubs, or gallops. Lung examination was notable for basilar crackles and mild wheezing. His abdomen was nontender, and his extremities had no edema or signs of a deep venous thrombosis.

Chest radiography revealed cardiomegaly with increased bilateral pulmonary edema, calcified pleural plaques, and pacemaker leads. Electrocardiography (ECG) was notable for a ventricular paced rhythm of 61 beats/min with underlying atrial fibrillation. Laboratory studies revealed the following (reference ranges provided parenthetically): hemoglobin, 13.4 g/dL (13.5-17.5 g/dL); leukocytes, 6.0 × 10^9/L (3.5-10.5 × 10^9/L); platelet count, 135 ×10^9/L (150-450 ×10^9/L); sodium, 141 mmol/L (135-145 mmol/L); potassium, 4.7 mmol/L (3.6-5.2 mmol/L); chloride, 104 mmol/L (98-107 mmol/L); creatinine, 1.6 mg/dL (0.8-1.3 mg/dL); international normalized ratio, 3.1 (0.9-1.1); and troponin T, 1.74 ng/mL (<0.01 ng/mL).

1. Based on the initial presentation, which *one* of the following is the *most likely* etiology of this patient's symptoms?

a. Pulmonary embolism (PE)
b. Pericarditis
c. Pneumonia
d. Non-ST elevation myocardial infarction (NSTEMI)
e. Unstable angina

The clinical presentation of a PE would consist of tachycardia, tachypnea, pleuritic chest pain, hypoxia, and potentially hemoptysis, which did not fit this patient's presentation. He also lacked any evidence of a deep venous thrombosis on examination, and ECG did not reveal the classic $S_1Q_3T_3$ pattern, although this is not a highly sensitive ECG finding for a PE and is even less so in the setting of a paced ECG.[1] Cardiac biomarker elevation may also be observed in a PE, but it would typically be lower than this patient's value. Therefore, a search for other etiologies for such a large cardiac troponin elevation should be prompted. Pericarditis would typically present with acute retrosternal pleuritic chest pain. The pain is typically exacerbated when the patient is in a supine position, with inspiration, and with coughing and improves with sitting up or leaning forward. Cardiac biomarker elevation could also be seen in acute pericarditis, but it would only be expected to be mild. Electrocardiography would also classically show widespread ST-segment elevations and PR-segment depressions.[2] Pneumonia would typically present with a cough, fever, an infiltrate on chest radiography, and leukocytosis, none of which are present in this patient. A NSTEMI typically presents with chest pain, diaphoresis, dyspnea, and elevated cardiac biomarkers. This scenario

Mayo Clin Proc. ■ September 2018;93(9):1320-1324 ■ https://doi.org/10.1016/j.mayocp.2018.01.029
www.mayoclinicproceedings.org ■

is most consistent with the patient's initial presentation, especially in the context of known coronary artery disease, and should be the first consideration in the differential diagnosis for this patient. An elevation of cardiac troponins distinguishes this patient's NSTEMI from a presentation of unstable angina.[3]

Although the differential diagnosis was broad, the most likely diagnosis for this initial presentation was an NSTEMI, and medical therapy was instituted. Early in the hospital course, the patient's chest pain had recurred and was responsive to intravenous nitroglycerin infusion in the cardiac intensive care unit.

2. Which *one* of the following is the *most appropriate* next test/procedure in the evaluation of this patient in this clinical scenario?

a. Cardiac magnetic resonance imaging (MRI)
b. Transthoracic echocardiography (TTE)
c. Transesophageal echocardiography
d. Computed tomographic angiography
e. Chest radiography

Although cardiac MRI is used to characterize myocardial infarction (MI), its greatest utility is in the post-MI risk stratification assessment rather than in the initial diagnostic work-up. Furthermore, cardiac MRI is not always feasible or available. It would not be the first step in evaluating a patient with an MI. Transthoracic echocardiography is an effective diagnostic tool in the evaluation of patients presenting with an MI because it can accurately identify the location and extent of any wall motion abnormalities that can correlate with current and past infarcts. Hypokinesis seen on TTE may include subendocardial infarcts, while regional akinesis or dyskinesis is more concerning for a transmural infarction.[4] Transesophageal echocardiography is a semi-invasive procedure and is not considered a first-line diagnostic imaging test in the setting of an acute coronary syndrome. Computed tomographic angiography has been found to be effective in detecting stenosis of the coronary arteries, but it is also not indicated when cardiac biomarker elevations are already noted, unless the suspicion for coronary artery disease is very low.[5] Moreover, computed tomographic angiography in patients with known coronary artery disease could be less than ideal because artifact from existing calcium deposits could make it challenging to accurately assess the coronary arteries. Chest radiography is typically used for evaluation of pulmonary problems including pneumonia and pulmonary edema.

We immediately initiated medical therapy with aspirin (81 mg) and atorvastatin (80 mg), and urgent TTE was obtained to assess left ventricular function, regional wall motion abnormalities, and other cardiac complications. Invasive coronary angiography was deferred initially given the patient's clinical stability and presence of a relative contraindication to invasive coronary angiography (supratherapeutic international normalized ratio, >3), with the contingency plan of reconsidering an invasive assessment as dictated by changes in his clinical course or based on the TTE findings. Transthoracic echocardiography revealed an anterior, loculated, heterogeneous (fluid/thrombus) pericardial fluid collection, left ventricular ejection fraction of 46%, regional wall motion abnormalities in the mid anterior left ventricular segments, and apical anterior, posterior, and septal segments with normal right ventricular function.

3. Based on the patient's imaging findings, which *one* of the following is the *most concerning* complication of the acute MI experienced by this patient?

a. Interventricular septal rupture
b. Post-MI syndrome
c. Papillary muscle dysfunction
d. Thrombus embolization
e. Left ventricular free wall rupture

Interventricular septal rupture would present with hemodynamic compromise, biventricular failure, a new harsh holosystolic murmur, and shunting between the ventricles would be appreciated on TTE.[6] Post-MI syndrome, otherwise known as Dressler syndrome, is an immune-mediated pericarditis against cardiac antigens exposed during myocardial injury and usually presents weeks to months after an MI.[7] Papillary muscle dysfunction would result in acute mitral regurgitation seen on TTE, a new mitral regurgitation murmur, pulmonary edema, hypotension, and cardiogenic shock.[6] Thrombus embolization would present with signs of stroke or ischemia in various parts of the body. The patient's physical examination

was negative for these findings. Left ventricular free wall rupture, classified as early-phase rupture (slit-like tear in infarcted myocardium) vs late-phase rupture (infarct expansion) leads to extravasation of blood into the pericardial sac, cardiac tamponade, or electromechanical dissociation and sudden death. The TTE for this patient was most concerning for a contained left ventricular free wall rupture.

Cardiovascular surgery was immediately consulted to assess candidacy for urgent surgical repair. At the bequest of the surgical consultative service, cardiac computed tomography was performed to delineate the extent of rupture and patency of the graft vessels. The study revealed a left ventricular anterolateral wall rupture with active extravasation of contrast medium within the pericardial space as well as marked left ventricular hypokinesis.

4. Which *one* of the following is the *definitive treatment* for this patient's left ventricular free wall rupture?

a. Pericardiocentesis
b. Surgical repair
c. Medical management (fluids, vasopressors)
d. Percutaneous coronary intervention
e. Percutaneous closure of the rupture site

Pericardiocentesis can be performed as a way to confirm that a pericardial fluid collection is indeed blood, signifying a free wall rupture. However, in the setting of a free wall rupture, pericardiocentesis is only a temporizing measure and can be associated with increased tension on the damaged myocardium leading to extension of the rupture, and therefore, in many circles, it is considered relatively contraindicated.[6] Immediate surgical repair in an ideally selected candidate is the definitive treatment for a left ventricular free wall rupture. Surgical repair can either be done with direct suture of the rupture with a Teflon strip reinforcement or using a bovine pericardial patch.[6] Medical management with fluids, vasopressors, and general hemodynamic stabilizing measures are typically used until a patient can undergo a definitive repair. Percutaneous coronary intervention can be performed early after diagnosis of an MI to reduce the risk of a rupture or after surgery to achieve revascularization goals.[8] Percutaneous closure of the rupture site is on the horizon of consideration, especially in the setting of high surgical risk. There are no studies to prove this approach as being efficacious, and as such, it cannot be recommended as a first-line form of therapy for a free wall myocardial rupture at this time.

After interpreting the TTE and computed tomographic angiography results, the cardiovascular surgery service expressed concern that although a surgical repair would be the ideal approach, the patient would be a high-risk surgical candidate considering his advanced age, prior coronary artery bypass grafting, current MI, acute heart failure, and progressive renal insufficiency. Palliative care was consulted, and a multidisciplinary team discussed the options available with the patient and his family. Eventually, he decided to forgo surgery. A do-not-resuscitate/do-not-intubate order was initiated with a contingency plan of pericardiocentesis to relieve some of the symptoms of pericardial tamponade. He was transferred from the cardiac care unit to the general medical ward with goals of symptom management. All antiplatelet and anticoagulation medications were discontinued. Transthoracic echocardiography performed 7 days after initial admission revealed a larger anterolateral rupture with systolic and end-diastolic flow through the defect, a left ventricular pseudoaneurysmal cavity, free-flowing pericardial effusion, left ventricular ejection fraction of approximately 30%, and mild right ventricular dysfunction.

5. Which *one* of these conservative management techniques would be *most effective* in improving the patient's survival?

a. Strict blood pressure control
b. Inotropes
c. Pericardiocentesis
d. Intravenous fluids
e. Aspirin and clopidogrel

Keeping systolic blood pressure between 100 and 120 mm Hg, along with strict bed rest for at least 10 days, has been found to improve survival.[9] This therapy is done preferably with the use of β-blockers, but a combination of medications including vasodilators and laxatives to prevent obstipation/constipation lead to reduced stress on an already weak myocardium and subsequently reduce

Mayo Clin Proc. ■ September 2018;93(9):1320-1324 ■ https://doi.org/10.1016/j.mayocp.2018.01.029
www.mayoclinicproceedings.org

the chance of a secondary rupture.[9] Although inotropes were used in the initial attempts at maintaining blood pressures, they are not the ideal choice for long-term medical management of free wall rupture.[9] Pericardiocentesis is used mostly for symptom management and reduction of tamponade physiology if clinically necessitated.[6] From clinical experience, it seems that if pericardiocentesis is mandated by clinical deterioration, the goal would be to evacuate enough of the pericardial contents to improve hemodynamic parameters rather than to evacuate the entire pericardial contents as would be done in a pericardial effusion with tamponade physiology. Intravenous fluids are used initially for hemodynamic stability but are not a long-term option for increasing survival. Aspirin and clopidogrel have no role in the management of a free wall rupture and may worsen the clinical situation.

The patient was stabilized and discharged to a skilled nursing facility. He returned to the hospital a month later because of increased dyspnea, hypoxemia, and pleural effusions. Thoracentesis revealed an exudative pleural effusion, which was likely multifactorial in nature considering the patient's impaired cardiac function and post—cardiac injury inflammation. Transthoracic echocardiography revealed the same-sized left ventricular anterolateral wall rupture with moderate-sized pericardial effusion and associated hematoma/coagulum and left ventricular ejection fraction of 30%. His condition was medically optimized, and he was discharged to a skilled nursing facility with a regimen of furosemide, metoprolol, simvastatin, spironolactone, and valsartan and encouraged to closely monitor his blood pressure.

DISCUSSION

Although the mortality from an acute MI continues to decline in this era of expeditious reperfusion therapy, left ventricular rupture is still one of the most serious mechanical complications of an acute MI with associated marked mortality. Within the subclasses of left ventricular rupture (ventricular septal rupture vs left ventricular free wall rupture), left ventricular free wall rupture has an incidence rate of 2% to 4%.[10] Furthermore, it can account for up to 15% of in-hospital mortality as a result of cardiac tamponade with rapid irreversible electromechanical dissociation.[11] Fortunately, a subset of people that experience a free wall rupture present with a subacute cardiac rupture that is well contained within the pericardial sac. These patients may survive several hours, which allows for diagnostic imaging as well as implementation of therapeutic measures.[11]

Typical risk factors that predispose to a free wall rupture include female sex, older age (>65 years old), first transmural MI, severe 1-vessel coronary artery disease with the lack of collateral formation, and the absence of previous angina. Although these features are generally considered to be some of the most important risk factors, it is important to keep in mind that each patient is different and one size never fits all. Interestingly, a history of multivessel disease or prior angina might be a protective factor because of the development of collateral vessels in response to cardiac stress.[11,12] The pathophysiology of a free wall rupture usually revolves around a modest-sized infarction leading to necrosis and thinning of the myocardial wall with poor collateral flow. This scenario makes the already thin wall susceptible to the shearing as the surrounding areas of normal myocardium contract rigorously against the stiffened, necrotic area. This process can lead to the dissection of blood through the myocardium into the pericardium.[13]

The clinical presentation of an acute free wall rupture is usually devastating and irreversible, with chest pain, electromechanical dissociation, shock, and death occurring shortly after rupture. The transmural tear leads to a severe pericardial tamponade with limited cardiac output and immediate death.[11] However, a subacute rupture usually leads to a slower, more contained hemopericardium with a limited tamponade physiology. This condition can present with chest pain, hypotension, syncope, muffled heart sounds, and hypoxemia.[11] In some instances, much like what happened with our patient, the subacute free wall rupture leads to a sealed rupture with pseudoaneurysm formation. These patients can be relatively stable and asymptomatic. Transthoracic echocardiography is the test of choice to establish the diagnosis of myocardial rupture with findings of pericardial effusion and tamponade physiology.[11] The absence of a pericardial effusion has a high

negative predictive value and excludes cardiac rupture in many patients.[11]

Early reperfusion in the setting of acute coronary syndrome has been found to be the prevailing force in the observed reduced incidence of myocardial rupture in contemporary practice.[11] There is also some evidence for prevention of a free wall rupture in high-risk patients that relies on strict blood pressure control with β-blockers and angiotensin-converting enzyme inhibitors to reduce wall stress.[10] Once the rupture is diagnosed, however, surgical repair is the definitive treatment of choice.[7,12] Close follow-up is recommended for those with subacute/contained ruptures to assess for hemodynamic stability and therapeutic pericardiocenteses.[12] Regardless of management (surgical repair vs conservative therapy), tight control of the patient's hemodynamic status and the severity of cardiogenic shock seem to be the biggest components that determine survival in patients with cardiac rupture after MI. Most importantly, it is crucial to align therapeutic options in the context of a patient's comorbidities. In the current clinical circumstance, surgical risk was exceedingly high and predicted a prolonged recovery, both of which were against the wishes of the family. In the appropriate clinical setting, medical therapy alone may be the best alternative to provide a balance between the risk of mortality on one hand and the ability to maintain a level of independence and comfort on the other. At the time this report was written, our patient continued to improve from a clinical standpoint and was being well maintained on medical therapy.

Potential Competing Interests: The authors report no competing interests.

Correspondence: Address to Nandan S. Anavekar, MB, BCh, Division of Cardiovascular Diseases, Mayo Clinic, 200 First St SW, Rochester, MN 55905 (anavekar.nandan@mayo.edu).

REFERENCES

1. Bělohlávek J, Dytrych V, Linhart A. Pulmonary embolism, part I: epidemiology, risk factors and risk stratification, pathophysiology, clinical presentation, diagnosis and nonthrombotic pulmonary embolism. *Exp Clin Cardiol*. 2013;18(2):129-138.
2. Snyder MJ, Bepko J, White M. Acute pericarditis: diagnosis and management. *Am Fam Physician*. 2014;89(7):553-560.
3. Thygesen K, Alpert JS, Jaffe AS, et al. Third universal definition of myocardial infarction. *Circulation*. 2012;126(16):2020-2035.
4. Douglas PS, Garcia MJ, Haines DE, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance. *J Am Coll Cardiol*. 2011;57(9):1126-1166.
5. Stein PD, Yaekoub A, Matta F, Sostman H. 64-Slice CT for diagnosis of coronary artery disease: a systematic review. *Am J Med*. 2008;121(8):715-725.
6. Kutty RS, Jones N, Moorjani N. Mechanical complications of acute myocardial infarction. *Cardiol Clin*. 2013;31(4):519-531.
7. Imazio M, Hoit BD. Post-cardiac injury syndromes: an emerging cause of pericardial diseases. *Int J Cardiol*. 2013;168(2):648-652.
8. Cheriex EC, de Swart H, Dijkman LW, et al. Myocardial rupture after myocardial infarction is related to the perfusion status of the infarct-related coronary artery. *Am Heart J*. 1995;129(4):644-650.
9. Figueras J, Cortadellas J, Evangelista A, Soler-Soler J. Medical management of selected patients with left ventricular free wall rupture during acute myocardial infarction. *J Am Coll Cardiol*. 1997;29(3):512-518.
10. Nozoe M, Sakamoto T, Taguchi E, Miyamoto S, Fukunaga T, Nakao K. Clinical manifestation of early phase left ventricular rupture complicating acute myocardial infarction in the primary PCI era. *J Cardiol*. 2014;63(1):14-18.
11. Solis C, Pujol D, Mauro V. Left ventricular free wall rupture after acute myocardial infarction. *Rev Argent Cardiol*. 2009;77(5):395-404.
12. Sulzgruber P, El-Hamid F, Koller L, et al. Long-term outcome and risk prediction in patients suffering acute myocardial infarction complicated by post-infarction cardiac rupture. *Int J Cardiol*. 2017;227:399-403.
13. Vanezis AP, Quadery R, Wasil M, Azher M. An unusual presentation of left ventricular free wall rupture following a silent myocardial infarction. *Br J Med Pract*. 2009;2(1):41-43.

CORRECT ANSWERS: 1. d. 2. b. 3. e. 4. b. 5. a.