Metastatic Signet Ring Adenocarcinoma:

An Unusual Cause of Cardiac Constriction

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Abstract

Pericardial constriction secondary to metastatic adenocarcinoma is exceedingly rare. We present the first recorded case of pericardial constriction secondary to metastatic signet-ring mucinous adenocarcinoma diagnosed by echocardiography. The cornerstones of echocardiographic diagnosis of constriction are the following: interventricular septal bounce phasic with respiration, M-mode recordings of the inferior vena cava, and the characteristic Doppler velocity patterns recorded from the mitral valve, hepatic veins, and mitral annulus.

Key words: Echocardiography, adenocarcinoma, cardiac constriction.

Case Report

A 59-YEAR-OLD AFRICAN-AMERICAN MAN with a long history of smoking tobacco and consuming excessive amounts of ethanol, came to the emergency department complaining of progressive chest pain, dyspnea, bilateral lower extremity edema, nausea and vomiting over the preceding month, along with more recent complaints of hoarseness and dysphagia.

Physical examination was significant for prominent jugular venous distension, S_4 gallop, dullness over the lung bases, ascites and 2+ pitting edema of both lower extremities. Laboratory data revealed iron deficiency anemia and an elevated serum carcinoembryonic antigen (CEA) level of 98.2 ng/mL (normal <3.0 ng/mL).

After the clinical diagnosis of congestive heart failure was established, chest radiograph and transthoracic echocardiogram (TTE) were obtained. Chest radiograph demonstrated bilateral pleural effusions and an elevated left hemidiaphragm. TTE revealed mild left ventricular (LV) hypertrophy and normal LV systolic function (LV ejection fraction of 60%). The size and function of the right heart were normal. Surrounding the epicardial surface of both ventricles and the right atrium was a 2–3-cm thick band of tissue extending into the pericardial transverse sinus along the ascending aorta (Fig. 1). The findings were sug-

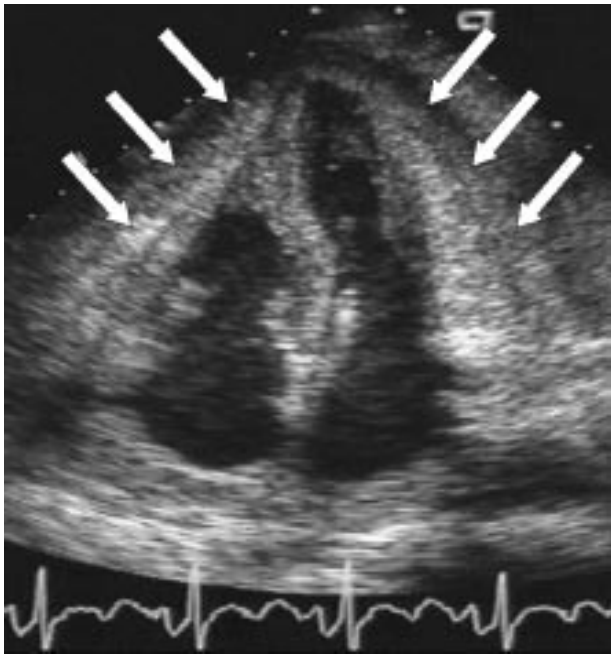

Fig. 1. Transthoracic echocardiogram in the apical 4-chamber view at end diastole reveals encasement of the heart by the signet-cell adenocarcinoma (arrows).

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gestive of either an organized pericardial effusion or a neoplastic invasion.

The presence of an interventricular septal bounce phasic with respiration was suggestive of constrictive physiology (1). The diagnosis of constriction was confirmed by Doppler velocity patterns of the mitral valve, hepatic veins and mitral annulus, as well as M-mode recordings of the inferior vena cava (IVC) (2).

Mitral Inflow

Spectral pulsed-wave Doppler recorded at the mitral valve leaflet tips, showed 66% respiratory variation in peak velocity of the mitral E wave with a short deceleration time (<150 msec) (Fig. 2).

Hepatic Vein

In the spectral pulsed-wave Doppler tracing of the hepatic vein, a marked expiratory enhancement in the peak velocity of the atrial reversal (AR) wave was noted (Fig. 3).

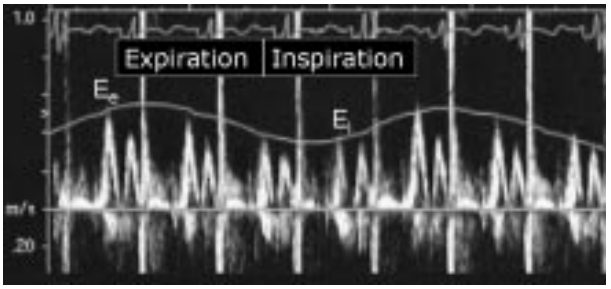

Fig. 2. Mitral blood inflow spectral pulsed-wave Doppler velocity tracings reveal a 66% respiratory variation (normal < 25%) in peak velocity of the mitral E wave (E_e = 70 cm/sec at end expiration; E_i = 42 cm/sec at end inspiration). Also note a very rapid deceleration of the E wave (<150 msec).

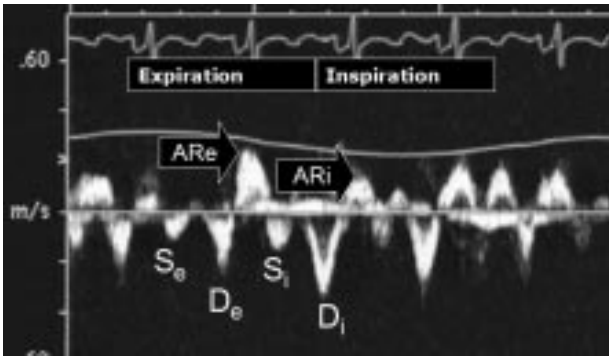

Fig. 3. Hepatic vein spectral pulsed-wave Doppler tracings demonstrate a marked expiratory enhancement in the peak velocity of the atrial reversal (AR) wave (AR_i = 14 cm/sec at end inspiration; AR_e = 26 cm/sec at end expiration). S and D refer to systolic and diastolic antergrade waves; the subscripts i and e refer to inspiration and expiration, respectively.

Mitral Annulus

Tissue Doppler recordings of the lateral mitral annulus showed a normal peak velocity of the early (E') wave at 17 cm/sec (normal >12 cm/sec) and an E'/E ratio of 0.44. Both findings were consistent with pericardial constriction but not myocardial restriction.

Inferior Vena Cava

During expiration, the IVC was dilated (diameter = 2.8 cm; normal < 2.5 cm). It collapsed less than 50% with inspiration (diameter = 1.9 cm) on M-mode recordings. This is indicative of a markedly elevated mean right atrial pressure (15–20 mm Hg), consistent with constrictive physiology. Pulmonary artery systolic pressure was estimated to be mildly elevated (35–40 mm Hg).

A double-contrast barium swallow esophagogram was normal. Five-millimeter axial computed tomography of the chest, abdomen and pelvis following oral and intravenous contrast administration revealed diffuse pericardial thickening, large bilateral pleural effusions and compressive lung atelectasis. In the abdomen, diffuse hepatomegaly with passive liver congestion and a large amount of ascites were noted. These findings were consistent with constrictive pericardial physiology. No abnormalities of the stomach, small bowel, colon or pancreas were found.

On surgical pericardiotomy a thickened pericardium with several irregularly shaped nodules in the pericardial fat were observed; no apparent abnormalities of the surrounding lung tissue were seen.

Surgical pathology revealed small-cell, signet-ring-type metastatic adenocarcinoma in the fibrous tissue of the pericardium with intralymphatic invasion of the surrounding adipose tissue. Mucicarmine staining confirmed the presence of a mucinous component and demonstrated CEA immunoreactivity.

The final diagnosis of a signet-ring-type adenocarcinoma of unknown primary location, leading to pericardial constriction, was established. While awaiting initiation of oncologic therapy, the patient had a cardiac arrest with pulseless electrical activity. Since his family refused autopsy, the immediate cause of death was not established.

Discussion

Pericardial constriction is characterized by an intractable encasement of the heart, which uncouples changes in intrapericardial pressures from

those in the pleural space. This can ultimately lead to heart failure despite preserved systolic and diastolic function of the myocardium.

Historically, tuberculosis was the leading cause of constrictive pericarditis (3, 4). However, in the modern era a majority of cases are idiopathic (42–49%); other causes are post-cardiac surgery (11–37%), mediastinal radiation (9–31%), connective tissue disorder (3–7%), infections including tuberculosis (3–6%), and rarely malignancy, medications, trauma, sarcoidosis, uremic pericarditis or asbestosis (1–10%) (5–7).

The prevalence of pericardial constriction in patients with metastatic pericardial tumors is about 1–11% (8). As with other cardiac tumors, secondary tumors of the pericardium are more common than primary ones (9). Metastatic adenocarcinomas are a rare cause of pericardial constriction; most of them are bronchial in origin (10–12).

In our patient the primary origin of adenocarcinoma could not be established although the elevated CEA level pointed toward a primary adenocarcinoma of the gastrointestinal tract. Direct tumor invasion or lymphagitic spread was probably responsible for the constrictive physiology.

This appears to be the first case recorded in English of metastatic signet-ring type adenocarcinoma leading to pericardial constriction diagnosed by echocardiography. In the only other previously reported case, bronchial adenocarcinoma metastasized to the pericardium; the diagnosis of constriction was suggested by right heart catheterization, and echocardiogram was reported to be technically difficult (8).

In pericardial constriction, a rigid pericardium isolates the heart from normal transmission of intrathoracic pressure changes and leads to ventricular interdependence. Due to pericardial encasement, the normal decrease in intrathoracic pressure that occurs during inspiration is transmitted only to the pulmonary and systemic venous systems, but not to the cardiac chambers.

In constriction, normal negative-pressure inspiration leads to a pressure drop in the pulmonary veins but not in the left ventricle. This in turn results in a markedly decreased pressure gradient across the mitral valve, and thus diminished left ventricular filling. On the contrary, the drop in pressure in systemic veins enhances venous return and right ventricular filling.

Since cardiac volume of the constricted heart is fixed, during inspiration the right ventricle fills at the expense of the left ventricle, while the opposite occurs during expiration. As a consequence, during inspiration there is an abrupt posterior motion ("septal bounce") of the interventricular septum (IVS) during early diastole, due to rapid right heart filling, followed by flattening of IVS in mid-diastole and an abrupt anterior motion occurring after atrial contraction (1, 13).

Doppler flow velocity patterns through the mitral and tricuspid valves and hepatic vein not only provide insight into hemodynamic changes that occur during respiration in constrictive pericarditis, but also help differentiate it from restrictive cardiomyopathy.

On Doppler echocardiography, the typical pattern of constrictive pericarditis consists of:

1. An inspiratory drop of more than 25% in the peak velocity of the early left ventricle diastolic filling wave (mitral E wave);
2. Deceleration time of mitral E wave less than 160 milliseconds;
3. An increase in the left ventricle isovolumic relaxation time with inspiration;
4. An increase in diastolic flow reversal with expiration in the hepatic veins (2, 14).
5. Doppler echocardiography with respiratory recordings has a sensitivity of 88% for the diagnosis of constrictive pericarditis (2).

On mitral annular pulsed-wave tissue Doppler imaging, the peak velocity of the early diastolic wave (e' wave) is not diminished in constrictive pericarditis. This finding distinguishes constrictive pericarditis from restrictive cardiomyopathy, in which the diastolic mitral annulus velocities are diminished (15, 16). In addition, the restrictive pattern is characterized by a predominantly inspiratory increase in diastolic flow reversal in hepatic veins (2).

Our case underscores the importance of echocardiography in the diagnosis of cardiac constriction, as the clinical presentation may be very nonspecific.

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