Case Report

A Case of Cardiac Herniation after Thoracic Blunt Trauma

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Abstract

We present a case of a male patient derived from a rural primary care center, after suffering thoracoabdominal blunt trauma in a MVA. He was hypotensive upon admission, chest X-rays showed a left hemo-pneumothorax and FAST revealed free fluid in the abdominal cavity, so he underwent emergent celiotomy. A grade III hepatic laceration and hemoperitoneum were noticed, and the liver was repaired. Cardiac contusion was diagnosed in the early postoperative period when observing dynamic EKG disturbances and persistent tachycardia. Control chest X-rays showed a mediastinal fluid-air level, and chest CT scan reported pneumopericardium and displacement of the heart, suggesting cardiac herniation. A longitudinal tear in the surface of the pericardial sac, which has completely opened and without suffering of the heart, was observed in thoracoscopic evaluation of the chest, so the defect was left wide open. The patient evolved well, with no further surgical interventions required.

Pericardial rupture in blunt chest trauma is uncommon, occurring in 0.4 - 3% of all cases, is commonly associated with high energy trauma and usually fatal. Mortality rate is as high as 75%, due to hemodynamic changes caused by cardiac herniation through the pericardial defect. In most cases, diagnosis is made postmortem. It should be suspected in cases of cardiac contusion, especially in those patients unresponsive to IV fluid or with sudden cardiogenic shock. EKG findings are in specific, but a deviated axis can be seen. Echocardiography and FAST are noninvasive and useful tools for quick diagnosis, while chest CT scan is more accurate.

ABBREVIATIONS

FAST: Focused Abdominal Sonography for Trauma; EKG: Electrocardiogram; CT: Contrast Tomography; MVA: Motor Vehicle Accidents; OR: Operating Room; ER: Emergency Room

INTRODUCTION

Pericardial rupture in blunt chest trauma is uncommon. It is estimated that it occurs between 0.4 – 3% of all blunt chest trauma, and is usually fatal, with a mortality rate as high as 75%, and with cardiac herniation being its main complication [1-3]. Usually, the diagnosis is made postmortem or during urgent chest exploration [4], and the mortality is mainly due to hemodynamic changes caused by cardiac herniation through the pericardial defect. Although, the majority of cases reported occur after thoracic surgical procedures for malignancy, as pneumonectomy for bronchogenic carcinoma, the same is unlikely in lung resections by infectious causes [5,6]. There are also some reports of pericardial rupture by congenital defects [6]. So far, there is not a standardized strategy for diagnosis and management, mainly due to the fact that most clinical reports are usually individual cases. We present the case of a male patient with diagnosis of pericardial rupture after blunt chest trauma.

CASE PRESENTATION

We present a case of a male patient transferred to the emergency room of Hospital San Vicente Foundation, derived from a rural primary care center, after suffering thoracoabdominal blunt trauma in a motor vehicle accident. At admission, his blood pressure was low, he had no head trauma and signs of external trauma in the left hemiabdomen; cervical and pelvis X-Ray did not showed fractures and FAST revealed free fluid in the abdominocavity and a left hemo-pneumothorax. A left chest tube was inserted, and celiotomy was performed, noticing a grade III hepatic laceration and hemoperitoneum, but nothing else. The liver was repaired with absorbable sutures and the abdominal wound closed. Head, cervical and chest CT scans were carried out after surgery, without signs of brain trauma, cervical or thoracic...
spine fractures, or great vessels trauma. Pulmonary contusion and residual left pneumothorax were noted.

In the early postoperative period, cardiac contusion was diagnosed after observing dynamic EKG disturbances and elevation of cardiac biomarkers. Due to an inadequate acoustic window, transthoracic echocardiography could not be performed, and a transesophageal echocardiography was done, which was reported as normal.

In spite of an overall stable clinical condition, during his evolution persistent tachycardia was noticed; a chest X-ray showed a mediastinal fluid-air level, so a chest CT scan was conducted. It informed the presence of a pneumopericardium, besides an abnormal cardiac morphology and location, seen displaced towards the posterior aspect of the left hemithorax (Figure 1); these findings were consistent with cardiac herniation due to pericardial rupture, and the patient was taken to the OR for urgent thoracoscopic evaluation of the pericardium. In surgery, a completely open pericardial sac was observed because of a longitudinal tear in its surface, from the diaphragmatic dome up to the mediastinal vessels, with the left phrenic nerve lying over the anterior flap of the opening. The heart was in its place, without evidence of cardiac suffering, so the decision to left the pericardium wide open was made, and a chest tube was inserted.

The patient evolved well, with no further surgical interventions required. A control chest CT scan was performed about a year and a half later, with spontaneous reposition of the heart to its usual location and no signs of herniation (Figure 2).

**DISCUSSION**

First descriptions of traumatic rupture of the pericardium date back to the 19th century, when Bricheteau observed a pneumopericardium in a patient in 1844 [6]. In 1864, while he was auscultating a patient with pneumopericardium, Morel-Lavallé identified a murmur with a sound similar to that of a watermill, which he denominated *bruit de Moulin* [7].

Traumatic disruption of the pericardium usually occurs in the setting of high energy trauma, and it is commonly associated with other injuries in the chest and rest of the body, with MVA being its main etiology. In their experience with over 20,000 patients admitted to a level I trauma center between 1979 and 1989, Fulda et al identified 59 patients with pneumopericardium that underwent emergent surgical exploration of the chest cavity. Of those, 68% where due to MVA, 10% occurred in motorcycle crashes, 7% in pedestrians, 7% by crushing trauma, and 2% were hit by a horse [1].

The actual cinematic mechanism explaining laceration of the pericardial sac has not been dilucidated, mostly due to inability to reproduce its conditions in trauma laboratories [4]. Costal and sternal fractures due to frontal trauma can lacerate the pericardium. Lateral trauma has been proposed as a factor for pericardial rupture; while the cephalic portion of the heart is fixed by lateral attachments, its apex acts as a back-and-forth moving pendulum, and if the energy transmitted during trauma is strong enough its deaccelerating mass can tear the pericardial sac [4].
Both the pleural and diaphragmatic aspects of the pericardium can be torn, with the former being more affected as seen on autopsies, specially the left part near the phrenic nerve. In the cases described by Fulda et al, 64% had left pericardial rupture, 18% were in the diaphragmatic portion, and 9% in the right side [1].

Mattox et al described 10 cases of traumatic pericardial laceration during a period of 20 years, which included 5 cases of cardiac herniation; 2 were patients admitted to the ER, while the rest were found at autopsy examination. They observed that when the pericardial rupture was an isolated injury, cardiac herniation through the defect led to worsening hemodynamics due to inflow and outflow obstruction, acting in a similar way as cardiac tamponade [4]. Besides, partial herniation of the apex can strangulate both the ventricles and coronary circulation, which in turn can provoke cardiovascular instability [3,4].

If myocardial contusion is present, the prognosis is worse because of a higher risk of cardiac failure. This condition can be found in up to 70% of high-energy blunt chest trauma as reported by Bodin et al. [9].

- There is no such thing as pathognomonic signs of cardiac herniation. In a series of 5 cases, Wright et al found clinical evidence of low cardiac output in 4 of them, and in one of them a late-appearing paradoxal pulse [6]. Pericardial rupture and cardiac herniation should be suspected in cases of: Previously stable patient with sudden cardiogenic shock, and symptoms and signs suggestive of cardiac tamponade, especially if these appear after changing the patient’s position [2,4,8].

- Patients with rapidly appearing hemodynamic instability right after suffering trauma, without evidence of major bleeding, particularly if it persists in spite of IV fluids and vasopressor medication [8].

- Heaved or displaced heart apex beat because of a closer location to the chest wall, usually accompanied by palpitations, shortness of breath, chest pain and a "bruit de Moulin" on auscultation [2,7].

In those patients with pericardial defects larger than 12 cm, strangulation of the heart is unlikely, with mild or no symptoms or clinical signs at all [2,10].

EKG changes are usually explained by cardiac contusion. However, in cases of cardiac herniation, EKG alterations that can be observed are [2,6,10,11]:

- Axis deviation due to luxation and rotation of the heart
- Dysrhythmias, usually those arising in the atria, a right bundle branch block or abnormal AV conduction
- Ischemic changes secondary to compression of coronary circulation

If the patient is stable, serial measurement of cardiac biomarkers is made at admission, and every 6 to 8 hours for the first 24 hours to evaluate cardiac blunt trauma [2,11].

Imaging is essential for the diagnosis. In chest X-ray, usual findings include a widened mediastinum with abnormal cardiac silhouette and a leftward shift, an enlarged pulmonary artery, pneumopericardium, pneumomediastinum, and sometimes, a left pleural effusion. Should be noticed that diagnosis is not usually straightforward because of these subtle and unspecific findings [2,4].

Transthoracic/Esophageal Echocardiography and FAST are quick and non-invasive tools particularly useful in the unstable patient, unresponsive to IV fluid therapy and inotropic support, and allow evaluation of alternate diagnoses, such as cardiac contusion or tamponade [10]. Although pneumomediastinum or subcutaneous emphysema can obstruct proper visualization of the heart, findings suggestive of an empty pericardial sac, a ruptured pericardium, pneumopericardium or a displaced heart all support diagnosis [2,10,11]. Nonetheless, operator variability and poor acoustic window, along with a low sensitivity to detect even large pericardial defects, render it an imaging modality that cannot be relied upon [10,11]. In this patient, it is suspected that superimposed air in the pericardial sac and a heart located it its normal place during echocardiographic precluded the visualization of the defect.

Pericardial rupture and cardiac herniation are best evaluated with computed tomography, which has become the imaging of choice [4,8,11]. Characteristic findings include: an "empty pericardial sac" sign, as a result of air occupying and outlining the pericardium due to displacement of the heart, focal pericardial discontinuity, pneumopericardium, a displaced heart or mediastinum non-explained by other causes such as atelectasis, massive hemothorax or tension pneumothorax, strangulation of the heart luxated through the pericardial defect can be seen as a "collar" sign, secondary signs of tamponade and heart failure such as a dilated inferior vena cava, periportal fluid, and ascites.

As exposed by Wright et al in their series, in 3 of the 5 patients described, angiography confirmed the diagnosis, and in one in whom surgical intervention was less urgent, should an angiographic evaluation been performed, pericardial rupture could have been diagnosed [6]. Positive features of pericardial rupture and cardiac herniation that can be seen are: abnormal filling of the apical portion of the left ventricle, alteration in the filling of the posterior wall due to compression from outside, and an irregular ejection pattern in the aortic pressure wave-form; sometimes, even an absent left coronary artery can be noticed [6]. Angiography is an invasive test, and because of increasing use and experience with CT, it has become obsolete.

In order to improve survival in patients with this type of injuries, a high index of suspicion should be raised. Cardiac strangulation being the main cause of cardiovascular instability, several authors have proposed pericardiostomy as the definite treatment, while others state that pericardial repair should be done whenever possible [1,2,5,11,12].

In 1983, Clark et al described a series of ten patients with pleuropericardiac hernias, most of them secondary to trauma [7]. Pericardial tears were found usually during urgent chest exploration for other reasons. Surgical treatment included relocation of the heart, opening the pericardium wide open or closing of the pericardial defect [7].

Whether the pericardium is left wide open or its defect is
corrected depends of the location and size of the rupture. Most of herniations occur with defects between 8 and 12 cm [1,12], so these are the ones that likely need to be repaired. To achieve this, closing the defect with nonabsorbable sutures or placing a mesh can be done; authors have proposed the use of Teflon, Gore-Tex, Marlex or PTFE [2,3,8,12]. Likewise, right-sided pericardial tears or in the diaphragmatic aspect require surgical repair [12]. There are not studies that compare which treatment is better.

REFERENCES


