

Intraoperative Transesophageal Echocardiography in Blunt Thoracic Trauma

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CARDIAC INJURY commonly occurs in patients who sustain blunt thoracic trauma; the incidence in patients who survive transport to a hospital has been estimated at 10% to 20% depending on the diagnostic criteria used.¹⁻⁸ Most commonly, the injury is limited to myocardial contusion and the structural integrity of the heart remains intact.⁵ Although the signs and symptoms of significant cardiac structural damage are often obvious, as in cardiac tamponade due to chamber rupture, in other cases they may be subtle, being masked or mimicked by previous cardiac surgery or myocardial infarction. Cardiac murmurs caused by traumatic valvular or septal rupture may not be heard in a noisy emergency room. The hemodynamic consequences of structural cardiac damage may not be immediately apparent due to multiple injuries and severe hypovolemia. Frequently other significant intrathoracic injuries coexist with cardiac damage,⁹ which may require urgent operation, thereby postponing tests such as two-dimensional (2D) surface echocardiography that would diagnose clinically undetected cardiac injury. A case of right atrial and tricuspid valve rupture is presented that was not clinically apparent in a patient with a previous myocardial infarction and coronary artery surgery. The diagnosis was made using 2D transesophageal echocardiography (TEE) in the operating room during thoracotomy for a related noncardiac injury.

CASE REPORT

A 34-year-old man was transferred to the University of Chicago Emergency Department for evaluation and treatment of blunt chest trauma following a motor vehicle accident. On admission the patient was awake and alert, but complained of left-sided chest pain and shortness of breath. His blood pressure was 140/80 mm Hg and heart rate was 110 beats/min. Physical examination showed a painful left lateral thoracic wall with visible soft tissue contusion and a well-healed median sternotomy scar from coronary artery bypass surgery following an inferior wall myocardial infarction 18 months previously. Breath sounds were clear bilaterally. Cardiac examination showed no rubs or murmurs, but there was moderate jugular venous distention. The abdominal examination was unremarkable. An electrocardiogram demonstrated an old inferior wall myocardial infarction and sinus tachycardia. Chest x-ray showed bilateral pulmonary contusions and a small left hemothorax. The mediastinum was thought to be widened, and a thoracic aortogram (Fig 1) suggested an intimal tear in the lower descending thoracic aorta.

The patient was taken to the operating room, where a left thoracotomy was performed to repair the aortic injury. At this time a TEE probe (model RT 5000; General Electric, Milwaukee, WI) was placed to monitor cardiac function during aortic repair. With manipulation of the lung and mediastinum, the patient became markedly hypotensive with an elevated central venous pressure. A short-axis view of the heart obtained with TEE showed good right ventricular function, a small hypokinetic left ventricle, and the presence of fluid and thrombus posteriorly in the pericardial space (Fig 2). The four-chamber view of the heart showed that the tricuspid valve had been avulsed with the papillary muscles prolapsing into an enlarged right atrium during systole (Fig 3).

Due to the severity of this cardiac injury and the normal appearance of the mediastinum, the aortic repair was abandoned

and the pericardium was opened immediately. A moderate amount of clotted blood was evacuated, relieving the cardiac tamponade. There was no continuing pericardial hemorrhage. The thoracotomy incision was closed and subsequently a secondary median sternotomy was performed. With the dissection of pericardial adhesions, significant bleeding ensued requiring the institution of femoral-femoral cardiopulmonary bypass. After inducing deep hypothermia and total circulatory arrest, the right atrium was visualized and opened. The tricuspid valve that had been ruptured at the level of all three papillary muscles (Fig 4) was resected and a porcine heterograft valve was sewn into the tricuspid annulus. A 2-cm tear in the atrial superior caval junction was also repaired. The circulatory arrest time at 20°C was 42 minutes. On rewarming on bypass, a slow sinus rhythm began. Unfortunately, severe biventricular dysfunction occurred, which was intractable despite inotropic support and balloon counterpulsation. The patient died during surgery. Autopsy showed an intimal tear limited to the descending thoracic aorta and no other unsuspected cardiac injuries.

DISCUSSION

Cardiac chamber rupture due to blunt trauma is usually a rapidly fatal injury, the majority of patients dying within 1 hour of injury.^{5,10} In previous reports all patients arriving at the hospital after injury were profoundly hypotensive with cyanosis and congestion of the upper body, and with markedly elevated central venous pressure.¹¹⁻¹⁸ These patients manifested cardiac tamponade from hemorrhage into the pericardial space.

Previous cardiac surgery obfuscated the expected clinical findings, because after cardiac surgery, the pericardial space is usually obliterated with adhesions between the epicardium, pericardium, and sternum. In addition, this condition limits and partitions the amount of blood that can accumulate around the heart, thereby limiting the degree of tamponade following cardiac chamber rupture. Because of these factors, cardiac injury following blunt trauma may not be suspected or may be overlooked.

Patients sustaining blunt cardiac trauma often have other injuries requiring urgent operative repair.^{3,9} Because of the urgency and because patients may arrive in the emergency department at times when consultant medical personnel are not immediately available, a wide array of diagnostic tests may not be obtained before surgery. Therefore, intraoperative monitoring using TEE may be a valuable adjunct in the diagnosis of blunt cardiac injuries.

Standard precordial echocardiography has a well-established role in the evaluation and prediction of complications after blunt chest trauma. A retrospective analysis of patients from the Mayo Clinic who had sustained blunt

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Fig 1. Aortogram shows a linear intimal tear just above the diaphragm.

chest trauma and had undergone general anesthesia in the following 6 months showed that an abnormal echocardiogram was associated with an increased incidence of hypotension occurring in the presence of an elevated central venous pressure, implying myocardial dysfunction.¹⁹ Hiatt et al

reported that patients with echocardiographic evidence of pericardial fluid and/or a wall motion abnormality had significantly higher CK-MB fractions, and a greater need for hemodynamic monitoring and inotropic support.²⁰

Standard transthoracic echocardiography is often adequate to image the heart in patients who have sustained chest trauma. Although Hiatt et al²⁰ reported satisfactory echocardiograms in all but one patient, Markiewicz et al reported inadequate studies in 6 of 27 patients.²¹ These inadequacies may have been attributable to the presence of pulmonary contusion, patient agitation, or mechanical ventilation, making surface echocardiography technically difficult. Although the patient described in this report may have benefited from preoperative surface echocardiography, it was felt that to obtain such a study would have needlessly delayed an urgent operation.

TEE provides rapid diagnosis of cardiac structural abnormalities. The placement of an ultrasound probe in the esophagus allows excellent visualization of cardiac structures, because there is no air between the probe and the heart. TEE has been used in the intraoperative setting for the diagnosis of myocardial ischemia manifested by wall motion abnormalities²²; when such ischemia is persistent, TEE strongly predicts postoperative myocardial infarction. TEE has also been used to guide mitral valve repair²³ and to assess cardiac filling status.²⁴ TEE is finding an expanded role in the echocardiography laboratory, where it is used for the evaluation of patients for whom surface echocardiography is limited (ie, obesity, chronic obstructive pulmonary disease, or mechanical ventilation).²⁵ TEE is also useful in assessing other valvular pathologies^{26,27} and in establishing

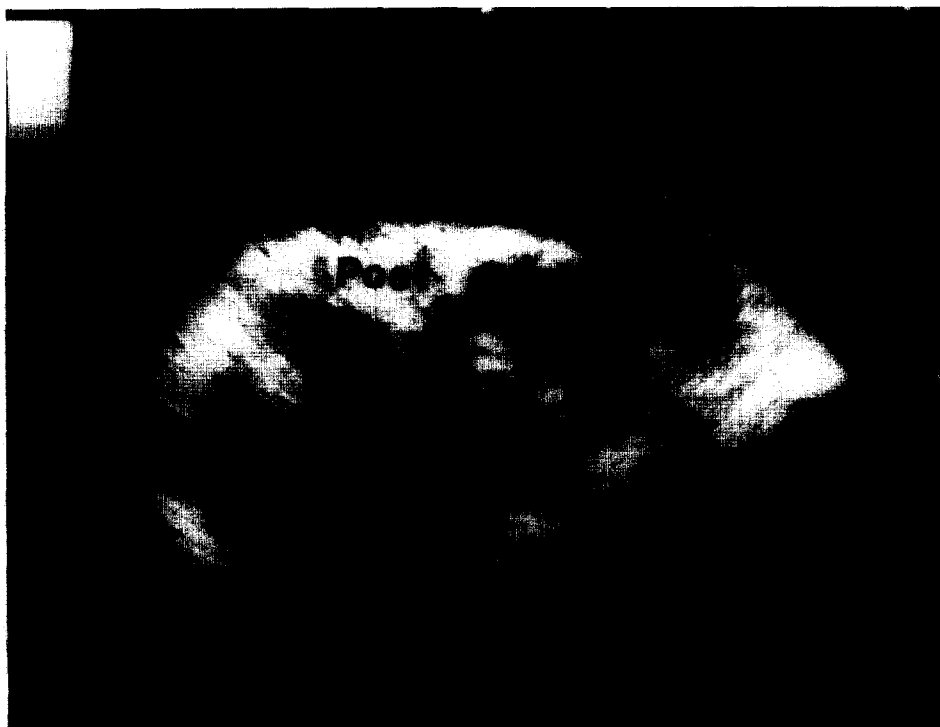


Fig 2. Short-axis view of heart. LV, left ventricle; RV, right ventricle; ant, anterior LV wall; post, posterior LV wall; lat, lateral LV wall; IVS, interventricular septum; PE, pericardial effusion; *, thrombus in pericardial space.



Fig 3. View of the right side of the heart. RA, right atrium; RV, right ventricle; TV, tricuspid valve; pap, papillary muscle.

the diagnosis of hypotension following cardiac surgery.²⁸ TEE appears to be a superior diagnostic procedure to identify patients with thoracic aortic dissections,²⁹ and has been used to diagnose papillary muscle rupture following acute myocardial infarction.³⁰ At this institution TEE has been used to guide complete operative drainage of complex, loculated pericardial effusions.

TEE provided an excellent means to diagnose the extent of the cardiac injuries in the present patient. It was useful in that it did not interrupt or delay the operation and allowed

the operative team to make the correct therapeutic maneuvers during significant, and otherwise inexplicable, systemic hypotension. Unfortunately, the patient died of his injuries, but the utility of TEE to demonstrate unsuspected life-threatening cardiac injuries was clearly demonstrated. Whether TEE should be used routinely in the operative management of thoracic trauma must be determined in the future by study of a series of patients with major trauma.

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Fig 4. Excised tricuspid valve. Note that all three papillary muscles have been avulsed.

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