
Blunt Traumatic Cardiac Rupture

A 5-Year Experience

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Blunt traumatic cardiac rupture is associated with a high rate of mortality. A review of the computerized trauma registry (1983 to 1988) identified 32 patients with this injury (ages 19 to 65 years; mean age, 39.5 years; 21 men and 11 women). Twenty-one patients (65.6%) were injured in vehicular crashes, 3 (9.4%) in pedestrian accidents, 3 (9.4%) in motorcycle accidents; 3 (9.4%) sustained crush injury; 1 (3.1%) was injured by a fall; and 1 (3.1%) was kicked in the chest by a horse. Anatomic injuries included right atrial rupture (13 [40.6%]), left atrial rupture (8 [25%]), right ventricular rupture (10 [31.3%]), left ventricular rupture (4 [12.5%]), and rupture of two cardiac chambers (3 [9.4%]). Diagnosis was made by thoracotomy in all 20 patients presenting in cardiac arrest. In the remaining 12 patients, the diagnosis was established in seven by emergency left anterolateral thoracotomy and in five by subxyphoid pericardial window. Seven of these 12 patients (58.3%) had clinical cardiac tamponade and significant upper torso cyanosis. The mean Injury Severity Score (ISS), Trauma Score (TS), and Glasgow Coma Scale (GCS) score were 33.8, 13.2, and 14.3, respectively, among survivors and 51.5, 8.3, and 7.0 for nonsurvivors. The overall mortality rate was 81.3% (26 of 32 patients), the only survivors being those presenting with vital signs (6 of 12 patients [50%]). All patients with rupture of two cardiac chambers or with ventricular rupture died. The mortality rate from myocardial rupture is very high. Rapid prehospital transportation, a high index of suspicion, and prompt surgical intervention contribute to survival in these patients.

CARDIAC RUPTURE AFTER blunt trauma is a relatively uncommon diagnosis; however it is associated with a very high mortality rate.¹ In 1955 DesForges reported the first successful repair of cardiac rupture after blunt trauma.² This opened a new era in the management of rupture of the heart because recognition of this injury was no longer purely academic. Since this initial success, multiple isolated accounts of repair of blunt cardiac ruptures have been reported.³⁻¹⁴ Within the past decade, a few small series containing patients with blunt

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cardiac rupture have been recorded.¹⁵⁻¹⁹ This present report reviews a 5-year experience with 32 patients who sustained cardiac rupture after blunt trauma and represents the largest series of treated patients with this entity reported to date.

Patient Data

During a 5-year period (beginning in 1983), 9522 patients who had sustained blunt trauma were admitted to the Shock Trauma Center of the Maryland Institute for Emergency Medical Services Systems (MIEMSS). An analysis of the MIEMSS trauma registry (prospectively collected data)²⁰ for the same period identified 32 patients with the diagnosis of blunt cardiac rupture. The mean age was 39.5 years, with a range from 19 to 65 years. There were 21 men and 11 women.

Twenty-one patients (65.6%) were injured in motor vehicle accidents (MVAs); three patients (9.4%) in auto-pedestrian accidents, and three in motorcycle accidents. Three sustained crush injury, one (3.1%) was injured by a fall, and one was kicked in the chest by a horse.

Twenty-eight patients were transported by helicopter and four by ground ambulance units. Thirty patients were admitted directly from the scene and two patients were transferred from local hospitals. The average time from injury to admission was 61.6 minutes.

The anatomic injuries included right atrial rupture (13 [40.6%]), left atrial rupture (8 [25%]), right ventricular rupture (10 [31.3%]), and left ventricular rupture (4 [12.5%]). Three patients (9.4%) had rupture of two cardiac chambers.

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Presentation

Twenty patients presented in cardiac arrest: 16 of them arresting at the scene and four during transport. Twelve patients had vital signs present at admission, and, of these, seven had systolic blood pressure less than 90 mmHg. Clinical evidence of cardiac tamponade (jugular venous distention, muffled heart sounds, and elevated central venous pressure) was noted in 7 of the 12 patients presenting with vital signs. These seven patients also were noted to have significant upper torso and facial cyanosis on admission. Two patients with associated pericardial lacerations presented with massive hemothorax and hemorrhagic shock. Visible external evidence of chest wall injury was noted in only 9 of the 32 patients.

Diagnosis

All 20 patients presenting in cardiac arrest underwent emergency thoracotomy in the admitting area, which established the diagnosis. Seven of the twelve patients who presented with vital signs had the diagnosis made by urgent left anterolateral thoracotomy, because of clinical deterioration. The remaining five patients underwent diagnostic subxyphoid pericardial window because of persistent hypotension or elevated CVP.

Associated thoracic injuries in the patients presenting with vital signs included multiple rib fractures (3), ruptured descending thoracic aorta (1), bilateral flail chest (1), ruptured superior vena cava (2), pericardial rupture (2), laceration of the pulmonary vein (1), and rupture of the inferior vena cava (2).

Treatment

Left anterolateral thoracotomy was performed in eight patients and median sternotomy in four patients of those presenting with vital signs. All 12 patients underwent primary repair of the injury without the assistance of cardiopulmonary bypass. Atrial injuries were primarily oversewn with 2-0 or 3-0 sutures, and ventricular injuries were repaired with deep pledgeted horizontal mattress sutures.

The 20 patients who presented in cardiac arrest all underwent immediate left anterolateral thoracotomy with attempted repair of the injury. Cardiopulmonary bypass also was not used in this group.

Morbidity/Mortality

The average Injury Severity Score (ISS) among all 32 patients was 49.7 (range, 29 to 75). The mean values for Trauma Score (TS) and Glasgow Coma Scale (GCS) were 5.4 and 6.0, respectively. The overall mortality rate was 81.3% (26 of 32 patients). None of the 20 patients pre-

senting in cardiac arrest survived. For the 12 patients presenting with vital signs, the mortality rate was 50%. Among these 12 patients, the mean ISS, TS, and GCS were 33.8, 13.2, and 14.3, respectively, for survivors and 51.5, 8.3, and 7 for nonsurvivors. All three patients with injury to two cardiac chambers died. No patient with ventricular rupture survived.

Seven patients arrested in the admitting area; however only three (43%) of these subsequently died. The average length of stay of the six survivors was 27 days (range, 9 to 54 days). One additional patient survived operation but died of multiple-organ failure 11 days later.

Discussion

The treachery of blunt trauma is probably nowhere more evident than in the patient who presents to the hospital with blunt cardiac rupture. Because the incidence of this injury in patients presenting alive is very low, the diagnosis may not be entertained initially. Martin et al.¹⁵ reported an incidence of only 0.5% among patients sustaining blunt trauma. Of 5378 trauma patients, 515 of whom sustained blunt chest trauma, Shorr et al.²¹ noted 14 cases (0.3%) of cardiac lacerations. In the present study, the incidence was also 0.3% among blunt trauma victims. Observation of blunt cardiac rupture at autopsy, however, indicates that this injury indeed is not rare.^{1,22}

The most common circumstance resulting in blunt rupture of the heart is an MVA. Of the 14 patients reported by Martin et al.,¹⁵ eight had sustained their injuries in automobile accidents. Williams and coworkers also reported seven patients with blunt traumatic cardiac rupture, all of whom were involved in MVAs.¹⁷ In the current report, 21 of the 32 patients were injured in MVAs. This was followed by auto-pedestrian accidents, falls from a height, and crush injury, which correlates with the literature.

The most compelling feature of cardiac rupture is cardiac tamponade. The patient may have multiple associated injuries that distort the clinical presentation. Hypotension out of proportion to identifiable blood loss should prompt cardiac tamponade as part of the differential diagnosis. Elevation of central venous pressure, jugular venous distention, and equalization of cardiac filling pressures also may suggest the diagnosis. Seventy-six per cent of patients surviving blunt cardiac rupture have been found to have significant upper torso, head, and neck cyanosis.²³ Of the 12 patients in our series who presented with vital signs, 7 had this finding documented. This is probably related to compression of the segment of the superior vena cava within the pericardium or compression of the vessels of the upper mediastinum from bleeding. Pericardiocentesis in cardiac trauma for purposes of diagnosis has been met with mixed reports in the

literature, with high false-positive or false-negative results.²⁴⁻²⁶ We have not found it to be a definitive test. Assuming that the patient is not in extremis, we prefer a subxyphoid diagnostic pericardial window performed in the operating room, with the patient fully prepared and draped for potential exploration.²⁷

Besides cardiac tamponade, the other primary manifestation of cardiac rupture is exsanguinating hemorrhage with massive hemothorax. This usually occurs in the small percentage (approximately 10%) of patients who have an associated pericardial laceration. Mortality rate has been reported to be much higher in these patients because of earlier exsanguination due to loss of the tamponading effect of the intact pericardium.²⁸ In our series two patients had associated pericardial lacerations and neither survived.

Several etiologic mechanisms of blunt cardiac rupture have been postulated. Severe precordial impaction, with posterior compression of the sternum and anterior chest wall, leading to cardiac entrapment between the sternum and vertebral column, is one possible mechanism.¹⁵ Both the atria and ventricles appear to be more vulnerable to compressive forces at points in the cardiac cycle of maximal filling.²² Rapid deceleration with resultant disruption of the atria from their junctions with the vena cava and pulmonary veins is another reported theory.¹⁵ Compression of the lower extremities and abdomen with rapid increase in intrathoracic hydrostatic pressure, due to upward displacement of blood, is another reputed mechanism.^{1,22} In this instance the precipitous increase in venous pressure is transmitted directly to the atrium.

The anatomic locations of cardiac rupture in 40 survivors with 42 injuries from the literature were reported by Leavitt et al.²³ in a collective review. These were as follows: right atrium, 21 patients (50%); right ventricle, 7 (17%); left atrium, 10 (24%); and left ventricle, 4 (9%). Thus, among survivors, the right atrium and right ventricle were twice as likely to be injured as the left atrium and left ventricle, respectively. Of the six survivors in the present series, five had right atrial injuries and one had left atrial injury. No survivors had ventricular injury.

The surgical approach to the patient with cardiac rupture varies in the literature with proponents of either median sternotomy or left anterior thoracotomy. Leavitt et al. found an almost equal incidence in their review, with 48% median sternotomy and 45% left anterior thoracotomy.²³ We prefer the left anterior thoracotomy for the patient in extremis because of expedience and simplicity. The sternum is divided when necessary. For the more stable patient who has undergone subxyphoid window, the incision is extended to median sternotomy. This provides good exposure of the heart and ascending aorta, can be extended easily for laparotomy, and is suitable for cardiopulmonary bypass.

Once the site of rupture has been identified, surgical management of the lesion is essentially straightforward. Hemorrhage from atrial injuries may be controlled by direct compression or application of a vascular clamp. The injury can then be oversewn. Insertion of a Foley catheter through the wound, with inflation of the balloon and gentle traction, also has been found to be useful in controlling hemorrhage.^{17,29} Ventricular injuries should be controlled by direct digital pressure and closure with mattress suture technique using pledget reinforcements.^{17,30} Injuries in close proximity to the coronary arteries require placement of sutures beneath the vessels in horizontal mattress fashion.^{16,29} Posterior lesions can be approached by temporary inflow occlusion for 1 to 2 minutes.^{17,30} Intracardiac injuries should be managed electively after cardiac catheterization unless hemodynamic instability precludes postponing cardiopulmonary bypass.^{16,31} After operation all patients definitely should be evaluated noninvasively for the possibility of occult septal and valvular injury.^{18,32,33}

The mortality rate in patients with blunt traumatic cardiac rupture is extremely high. Shorr et al.²¹ reported no survivors in 14 patients. Martin et al.¹⁵ noted a 50% mortality rate and Mattox et al.¹⁶ reported a mortality rate of 85%. The latter corresponds to our current reported mortality rate of 81.3%. For patients presenting with vital signs, the mortality rate in our group was 50%.

Some form of cardiac injury has been reported in 75% of traumatized patients, with blunt cardiac trauma accounting for at least 5% of the 50,000 highway deaths in the United States each year.¹⁸ The diagnosis may be very difficult because many patients have associated injuries.^{21,23} One must be mindful of the syndrome of cardiac tamponade in the patient with severe blunt chest trauma. If a patient arrests in the admitting area with a diagnosis of cardiac tamponade subsequent to blunt trauma, our data suggest a survival rate of more than 50% with immediate thoracotomy. With more sophisticated transportation facilities and prehospital care, more of these patients are being seen alive by emergency personnel. The survival rate can be increased only by a high index of suspicion, aggressive expeditious diagnostic evaluation, and prompt appropriate surgical management.

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