HARRISON'S PRINCIPLES OF INTERNAL MEDICINE — 22nd Edition

Cardiac Trauma

Chapter 283 | Part 6: Disorders of the Cardiovascular System | Part 6 – Cardiovascular Disorders | DETAILED EDITION

KEY CLINICAL POINTS

1. Metastatic cardiac tumors are much more common than primary cardiac tumors.
2. Rapid deceleration following motor vehicle accidents may be associated with significant cardiac injury even in the absence of external signs of thoracic trauma.
3. Normal serial troponin levels after chest trauma are very unlikely to have sustained cardiac injury.
4. A normal troponin level at 6–8 h after chest trauma essentially excludes blunt cardiac injury (BCI).
5. Penetrating cardiac injury associated with hemodynamic instability is a surgical emergency requiring immediate resuscitation and thoracotomy.
6. Gunshot wounds are associated with higher mortality (20% survival) compared to knife wounds (65% survival) in penetrating trauma.
7. The right ventricle (RV) is the most frequently injured cardiac chamber in penetrating trauma.
8. Commotio cordis is an electrical phenomenon occurring in adolescents during sporting events due to impact to the chest wall overlying the heart during repolarization.
9. Primary cardiac lymphoma is the most chemotherapy-sensitive cardiac malignancy.
10. Pericardiocentesis is a temporizing measure for tamponade but usually requires definitive surgical therapy.

FIGURES IN THIS CHAPTER

1. DEFINITION & OVERVIEW

• Cardiac trauma may be caused by either penetrating or nonpenetrating trauma.

• Nonpenetrating trauma is often referred to as blunt cardiac injury (BCI).

• Penetrating injuries most often result from gunshot or knife wounds, and the site of entry is usually obvious.

• Blunt cardiac injuries most often occur during motor vehicle accidents, either from rapid deceleration or from impact of the chest.

• Blunt cardiac injuries can also result from falls from heights, crush injuries, blast injuries, violent assault, or significant physical contact during sporting events.

• Rapid deceleration following motor vehicle accidents may be associated with significant cardiac injury even in the absence of external signs of thoracic trauma.

• Harrison's defines metastatic cardiac tumors as lesions that are much more common than primary cardiac tumors, and their incidence is likely to increase as the life expectancy of patients with various forms of malignant neoplasms is extended by more effective therapy and improved imaging modalities allow earlier identification of metastatic disease.

• Cardiac metastases may occur with any tumor type, but the relative incidence is especially high in malignant melanoma and, to a somewhat lesser extent, leukemia and lymphoma.

• In absolute terms, the most common primary sites from which cardiac metastases originate are carcinoma of the breast and lung, reflecting the high incidence of these malignancies.

• Cardiac metastases almost always occur in the setting of widespread primary disease; most often, there is either primary or metastatic disease elsewhere in the thoracic cavity.

• Cardiac metastases may occur via hematogenous or lymphangitic spread or by direct tumor invasion.

• While they generally manifest as small, firm nodules, diffuse infiltration also may occur, especially with sarcomas or hematologic neoplasms.

• The pericardium is most often involved, followed by myocardial involvement of any chamber and, rarely, by involvement of the endocardium or cardiac valves.

• Primary cardiac lymphoma is the most chemotherapy-sensitive cardiac malignancy, with long-term survival achieved in ~40% of treated individuals.

• The one exception appears to be cardiac lymphosarcomas, which may respond to a combination of chemo- and radiotherapy.

1.1 Cardiac Tumors

• Primary cardiac malignancy: Primary cardiac lymphoma is the most chemotherapy-sensitive cardiac malignancy.

• Response to therapy: The response of cardiac sarcomas to radiotherapy and/or chemotherapy is generally poor.

• Exception: Cardiac lymphosarcomas may respond to a combination of chemo- and radiotherapy.

• Imaging: Cardiac MRI offers superb image quality and plays a central role in the diagnostic evaluation of metastases and cardiac tumors in general.

• Pericardiocentesis: May allow for a specific cytologic diagnosis in patients with malignant pericardial effusions with a reported sensitivity of 67–92%.

• Angiography: Is rarely necessary but may help to delineate discrete myocardial lesions.

• Treatment: Most patients with cardiac metastases have advanced malignant disease; thus, therapy is generally palliative and consists of controlling symptoms and treatment of the primary tumor.

• Symptomatic malignant pericardial effusions: Should be drained by pericardiocentesis.

• Refractory or recurrent malignant pericardial effusion: The surgical creation of a pericardial window allowing for drainage of the effusion to the adjacent pleural or peritoneal space may prevent recurrent pericardial tamponade.

• Palliative measure: Prolonged drainage (3–5 days) and concomitant instillation of a sclerosing agent (e.g., bleomycin) can be considered as a palliative measure in terminally ill patients.

• Goals of care: Given the overall poor prognosis of these patients, discussions regarding goals of care and involvement of palliative care services are often appropriate.

1.2 Blunt Cardiac Injury (BCI)

• Myocardial contusion: A nonspecific term that has been used to describe a broad spectrum of nonpenetrating cardiac injuries.

• Consequences: The most serious consequence of nonpenetrating cardiac injury is myocardial rupture.

• Rupture types: Free wall rupture may result in hemopericardium and tamponade while a ventricular septal rupture can result in significant intracardiac shunting.

• Coronary artery injury: BCI may also result in dissection, occlusion, or laceration of the coronary arteries.

• Valvular insufficiency: Most commonly involving mitral and tricuspid valves and occasionally the aortic valve.

• Pericardial effusion and tamponade: Resulting from free wall rupture or coronary artery laceration.

• Commotio cordis: Blunt, nonpenetrating, often innocent-appearing injuries to the chest may trigger ventricular fibrillation even in the absence of structural myocardial damage.

• Commotio cordis demographics: Occurs most often in adolescents during sporting events (e.g., baseball, hockey, football, and lacrosse).

• Commotio cordis mechanism: An electrical phenomenon that probably results from an impact to the chest wall overlying the heart during the susceptible phase of repolarization (just before the peak of the T wave).

• Commotio cordis survival: Survival depends on prompt defibrillation.

• Takotsubo syndrome: Sudden emotional or physical trauma, even in the absence of direct cardiac trauma, may precipitate a transient catecholamine-mediated cardiomyopathy referred to as takotsubo syndrome or apical ballooning syndrome.

• Aortic rupture: Rupture or transection of the aorta, usually just above the aortic valve or at the site of the tethering ligamentum arteriosum, is a common consequence of nonpenetrating chest trauma and is the most common vascular deceleration injury.

• Aortic rupture presentation: The clinical presentation may be similar to that of aortic dissection; the arterial pressure and pulse amplitude may be increased in the upper extremities and decreased in the lower extremities, and chest x-ray may reveal mediastinal widening.

• Aortic rupture prognosis: Aortic rupture into the left thoracic space is almost universally fatal.

• Contained rupture: The rupture may occasionally be contained by the aortic adventitia, resulting in a false, or pseudo-, aneurysm that may be discovered months or years after the initial injury.

1.3 Penetrating Cardiac Injury

• Mechanism: Penetrating injuries of the heart produced by knife or bullet wounds usually result in rapid clinical deterioration and frequently in death as a result of hemopericardium/pericardial tamponade or massive hemorrhage.

• Survival rates: Up to half of such patients may survive long enough to reach a specialized trauma center if immediate resuscitation is performed.

• Prognosis factors: Prognosis in these patients relates to the mechanism of injury, the specific cardiac chamber(s) involved, and their clinical condition at presentation.

• Gunshot vs Knife: Gunshot wounds are associated with a higher mortality than are knife wounds.

• Survival statistics: Twenty percent of shooting victims survive versus up to 65% of stabbing victims.

• Reason for survival difference: This is likely in part because ballistic wounds are more frequently associated with multichamber cardiac injury.

• Chamber involvement: As a result of its anterior position in the chest, the right ventricle (RV) is the most frequently injured cardiac chamber, followed by the left ventricle (LV); isolated atrial injury is uncommon.

• Multichamber injury: Most reports indicate that multichamber involvement carries a worse prognosis than single-chamber injury.

• Iatrogenic injuries: Cardiac perforation of the right atrium, the RV free wall, or the interventricular septum may occur as a complication of cardiac procedures including placement of central venous/intracardiac catheters, insertion of pacemaker/defibrillator leads, or performance of RV endomyocardial biopsies; and coronary arterial perforation can occur during deployment of intracoronary stents.

• Iatrogenic prognosis: These iatrogenic injuries are associated with a better prognosis than are other forms of penetrating cardiac trauma, likely related to a more limited degree of cardiac injury and the rapid availability of corrective therapies.

• Late complications: Some patients with penetrating chest injuries are hemodynamically stable at presentation and without symptoms to suggest cardiac injury; however, as many as 20% of these patients will have occult penetrating cardiac trauma.

• Late presentation: Occasionally, patients who survive penetrating cardiac injuries may subsequently present days or weeks later with a new cardiac murmur or heart failure as a result of mitral or tricuspid regurgitation or an intracardiac shunt (i.e., ventricular or atrial septal defect, aortopulmonary fistula, or coronary arteriovenous fistula) that was undetected at the time of the initial injury or developed subsequently.

• Investigation for late complications: Therefore, trauma patients should be examined carefully several weeks after the injury. If a mechanical complication is suspected, it can be confirmed by echocardiography or cardiac catheterization.

2. EPIDEMIOLOGY

• Metastatic cardiac tumors are much more common than primary cardiac tumors.

• Incidence of metastatic tumors is likely to increase as the life expectancy of patients with various forms of malignant neoplasms is extended by more effective therapy and improved imaging modalities allow earlier identification of metastatic disease.

• Relative incidence of metastatic tumors is especially high in malignant melanoma and, to a somewhat lesser extent, leukemia and lymphoma.

• Most common primary sites for cardiac metastases are carcinoma of the breast and lung.

• Cardiac metastases are clinically apparent only ~10% of the time.

• Cardiac metastases are rarely the cause of the patient's presentation.

• Cardiac metastases rarely are the cause of death.

• The vast majority occur in the setting of a previously recognized malignant neoplasm.

• Blunt cardiac injuries most often occur during motor vehicle accidents.

• Blunt cardiac injuries can also result from falls from heights, crush injuries, blast injuries, violent assault, or significant physical contact during sporting events.

• Commotio cordis occurs most often in adolescents during sporting events.

3. ETIOLOGY & PATHOPHYSIOLOGY

• Penetrating injuries: Produced by knife or bullet wounds.

• Nonpenetrating injuries: Often referred to as blunt cardiac injury (BCI).

• Mechanism of BCI: Rapid deceleration or impact of the chest.

• Mechanism of Commotio Cordis: Impact to the chest wall overlying the heart during the susceptible phase of repolarization (just before the peak of the T wave).

• Mechanism of Aortic Rupture: Deceleration injury, usually just above the aortic valve or at the site of the tethering ligamentum arteriosum.

• Pathology of BCI: The injured myocardium is pathologically similar to infarcted myocardium.

• Pathology of Metastases: Cardiac metastases may occur via hematogenous or lymphangitic spread or by direct tumor invasion.

• Pathology of Metastases: While they generally manifest as small, firm nodules, diffuse infiltration also may occur, especially with sarcomas or hematologic neoplasms.

• Pathology of Metastases: The pericardium is most often involved, followed by myocardial involvement of any chamber and, rarely, by involvement of the endocardium or cardiac valves.

3.1 Molecular & Cellular Mechanisms

• Commotio cordis: An electrical phenomenon that probably results from an impact to the chest wall overlying the heart during the susceptible phase of repolarization.

• Aortic Rupture: Rupture or transection of the aorta, usually just above the aortic valve or at the site of the tethering ligamentum arteriosum, is a common consequence of nonpenetrating chest trauma.

• Myocardial Contusion: A nonspecific term that has been used to describe a broad spectrum of nonpenetrating cardiac injuries.

3.2 Tumor Pathogenesis

• Metastatic spread: Cardiac metastases may occur via hematogenous or lymphangitic spread or by direct tumor invasion.

• Tumor Types: Most common primary sites from which cardiac metastases originate are carcinoma of the breast and lung.

• High Incidence Tumors: Malignant melanoma, leukemia, and lymphoma have especially high relative incidence for cardiac metastases.

• Primary Cardiac Malignancy: Primary cardiac lymphoma is the most chemotherapy-sensitive cardiac malignancy.

• Lymphosarcoma Response: Cardiac lymphosarcomas may respond to a combination of chemo- and radiotherapy.

4. CLINICAL FEATURES

• Cardiac metastases: Clinically apparent only ~10% of the time.

• Cardiac metastases: Are usually not the cause of the patient's presentation.

• Cardiac metastases: Rarely are the cause of death.

• Cardiac metastases: Occur in the setting of a previously recognized malignant neoplasm.

• Cardiac metastases: Clinical presentation reflects more the location and size of the tumor than its histologic type.

• Symptomatic cardiac metastases: May result in a variety of clinical features, including dyspnea, acute pericarditis, cardiac tamponade, ectopic tachyarrhythmias, heart block, and CHF.

• Symptoms: Chest pain is common following thoracic trauma.

• Chest pain: While it can indicate cardiac ischemia or pericardial injury, it often reflects musculoskeletal trauma.

• Myocardial necrosis: May occur as a direct result of the blunt injury or as a result of traumatic coronary laceration, dissection, or thrombosis.

• ECG findings: Electrocardiographic (ECG) findings are nonspecific but may reveal features consistent with pericarditis or may demonstrate low QRS voltage and electrical alternans in the setting of a large pericardial effusion.

• ECG abnormalities: Sinus tachycardia, RBBB, heart block, ST-T wave abnormalities, atrial and ventricular arrhythmias.

• Physical examination: The physical examination may be challenging in the setting of chest wall injury.

• Physical examination findings: Patients should be carefully examined to detect pericardial rubs, cardiac murmurs, and evidence of pericardial tamponade.

• Penetrating injury presentation: Penetrating injuries of the heart produced by knife or bullet wounds usually result in rapid clinical deterioration and frequently in death as a result of hemopericardium/pericardial tamponade or massive hemorrhage.

• Penetrating injury symptoms: Some patients with penetrating chest injuries are hemodynamically stable at presentation and without symptoms to suggest cardiac injury.

• Late symptoms: Occasionally, patients who survive penetrating cardiac injuries may subsequently present days or weeks later with a new cardiac murmur or heart failure as a result of mitral or tricuspid regurgitation or an intracardiac shunt.

• Aortic rupture presentation: The clinical presentation may be similar to that of aortic dissection.

• Aortic rupture signs: Arterial pressure and pulse amplitude may be increased in the upper extremities and decreased in the lower extremities, and chest x-ray may reveal mediastinal widening.

4.1 Metastatic Tumor Symptoms

• Dyspnea

• Acute pericarditis

• Cardiac tamponade

• Ectopic tachyarrhythmias

• Heart block

• CHF

4.2 Blunt Cardiac Injury Symptoms

• Chest pain

• ECG abnormalities (Sinus tachycardia, RBBB, heart block, ST-T wave abnormalities, atrial and ventricular arrhythmias)

• Low QRS voltage

• Electrical alternans

4.3 Penetrating Cardiac Injury Symptoms

• Rapid clinical deterioration

• Death (frequently)

• Hemopericardium

• Pericardial tamponade

• Massive hemorrhage

• New cardiac murmur (days or weeks later)

• Heart failure (days or weeks later)

5. DIFFERENTIAL DIAGNOSIS

• Cardiac metastases: Signs and symptoms may also result from myocarditis, pericarditis, or cardiomyopathy induced by radiotherapy or chemotherapy.

• High index of suspicion: A high index of suspicion for cardiac involvement should be maintained for patients with malignant disease who develop these symptoms.

• Chest pain: While it can indicate cardiac ischemia or pericardial injury, it often reflects musculoskeletal trauma.

• Commotio cordis: Must be distinguished from structural myocardial damage.

• Aortic rupture: Must be distinguished from aortic dissection.

• Takotsubo syndrome: Must be distinguished from direct cardiac trauma.

• Iatrogenic injuries: Must be distinguished from other forms of penetrating cardiac trauma.

5.1 Mimickers of Cardiac Trauma

• Myocarditis

• Pericarditis

• Cardiomyopathy induced by radiotherapy or chemotherapy

• Musculoskeletal trauma

5.2 Mimickers of Blunt Cardiac Injury

• Commotio cordis (electrical phenomenon)

• Takotsubo syndrome (catecholamine-mediated cardiomyopathy)

• Aortic dissection

6. INVESTIGATIONS & DIAGNOSIS

• ECG: Electrocardiographic (ECG) findings are nonspecific but may reveal features consistent with pericarditis or may demonstrate low QRS voltage and electrical alternans in the setting of a large pericardial effusion.

• ECG abnormalities: Sinus tachycardia, RBBB, heart block, ST-T wave abnormalities, atrial and ventricular arrhythmias.

• Biomarkers: Elevated cardiac Troponin I or T are most specific biomarkers.

• CK-MB: Serum creatine kinase, myocardial band (CK-MB) isoenzyme levels are increased in ~20% of patients who experience blunt chest trauma but may be falsely elevated in the presence of massive skeletal muscle injury and should not be relied upon to confirm the diagnosis of BCI in the setting of trauma.

• Troponin: Cardiac troponin levels are more specific for identifying cardiac damage; patients with normal serial troponin levels after chest trauma are very unlikely to have sustained cardiac injury.

• Troponin threshold: When combined with a normal ECG, a normal troponin level at 6–8 h after chest trauma essentially excludes BCI.

• Chest x-ray: On chest x-ray, the cardiac silhouette is most often normal but may be enlarged or exhibit a bizarre contour.

• Chest x-ray findings: Mediastinal widening may be seen in aortic rupture.

• Echocardiography: Echocardiography is useful for detecting structural and functional sequelae of BCI, including regional wall motion abnormalities (most commonly involving the right ventricle, interventricular septum, or left ventricular apex), pericardial effusion, valvular dysfunction, and ventricular or ventricular septal rupture.

• TTE: A transthoracic echocardiogram (TTE) should be performed in all patients with suspected BCI, especially in those with an abnormal ECG, elevated troponin, or hemodynamic instability.

• TEE: Transesophageal echocardiography should be considered for patients in whom adequate TTE images cannot be obtained.

• MRI: Cardiac MRI offers superb image quality and plays a central role in the diagnostic evaluation of metastases and cardiac tumors in general.

• CT: CT and radionuclide imaging may define the tumor burden more clearly.

• Pericardiocentesis: May allow for a specific cytologic diagnosis in patients with malignant pericardial effusions with a reported sensitivity of 67–92%.

• Angiography: Angiography is rarely necessary but may help to delineate discrete myocardial lesions.

• Diagnosis of occult injury: As many as 20% of patients with penetrating chest injuries will have occult penetrating cardiac trauma.

• Diagnosis of late complications: If a mechanical complication is suspected, it can be confirmed by echocardiography or cardiac catheterization.

Table 1 Table 283-1 Spectrum of Cardiac Abnormalities Following Blunt Cardiac Injury

ABNORMALITY	COMMENTS
ECG abnormalities	Sinus tachycardia, RBBB, heart block, ST-T wave abnormalities, atrial and ventricular arrhythmias
Elevated cardiac Troponin I or T	Most specific biomarkers
Focal wall motion abnormality or hematoma	Most commonly involving RV free wall, LV apex, and interventricular septum
Valvular insufficiency	Most commonly involving mitral and tricuspid valves and occasionally the aortic valve
Myocardial rupture	Ventricular septal defect or free wall rupture
Coronary artery injury	Most commonly involving the LAD; usually presents as STEMI
Pericardial effusion and tamponade	Resulting from free wall rupture or coronary artery laceration

6.1 Diagnostic Criteria & Thresholds

• Normal ECG + Normal Troponin at 6–8 h: Essentially excludes BCI.

• Pericardiocentesis Sensitivity: 67–92% for malignant pericardial effusions.

• Troponin Specificity: Elevated cardiac Troponin I or T are most specific biomarkers.

6.2 Imaging Modalities

• TTE: Transthoracic echocardiogram.

• TEE: Transesophageal echocardiography.

• MRI: Cardiac MRI.

• CT: Computed tomography.

• Radionuclide imaging: For tumor burden.

7. MANAGEMENT & TREATMENT

• Tumors Metastatic to the Heart: Therapy is generally palliative and consists of controlling symptoms and treatment of the primary tumor.

• Symptomatic malignant pericardial effusions: Should be drained by pericardiocentesis.

• Refractory or recurrent malignant pericardial effusion: The surgical creation of a pericardial window allowing for drainage of the effusion to the adjacent pleural or peritoneal space may prevent recurrent

pericardial tamponade.

• Palliative measure: Prolonged drainage (3–5 days) and concomitant instillation of a sclerosing agent (e.g., bleomycin) can be considered as a palliative measure in terminally ill patients.

• Goals of care: Given the overall poor prognosis of these patients, discussions regarding goals of care and involvement of palliative care services are often appropriate.

• BCI Treatment: The treatment of BCI depends on the specific injury sustained.

• Low risk patients: Hemodynamically stable patients with a normal ECG and normal serial troponin levels are at low risk for BCI and usually do not require hospital admission for cardiac issues.

• Telemetry monitoring: Patients with an abnormal ECG, including those with conduction disturbances, and/or elevated troponin but normal echocardiogram usually warrant 24–48 h of telemetry monitoring.

• Other specific cardiac treatment: Is not usually required in the absence of the development of arrhythmias, as conduction disturbances are often transient.

• Mechanical complications: Patients with mechanical complications (acute valvular insufficiency, myocardial rupture) require urgent operative correction.

• Penetrating Cardiac Injury Treatment: Penetrating cardiac injury associated with hemodynamic instability is a surgical emergency and requires immediate resuscitative measures including endotracheal intubation, establishment of large-bore intravenous access to facilitate massive volume resuscitation, and immediate thoracotomy to allow for pericardial drainage and repair of cardiac injuries.

• Cross-clamping: Occasionally, cross-clamping of the descending aorta is required to perfuse the heart and brain preferentially until hemodynamic stability can be achieved.

• Pericardiocentesis: Pericardiocentesis may be lifesaving in patients with tamponade but is usually only a temporizing measure while awaiting definitive surgical therapy.

• Constriction: In some survivors of penetrating cardiac injury, the pericardial hemorrhage may predispose to the development of constriction, which may require surgical decortication.

• Local hematoma: Local hematoma formation may compress adjacent vessels and produce ischemic symptoms.

• Arteriovenous fistulas: Arteriovenous fistulas may develop, occasionally resulting in high-output heart failure.

• Occult injury management: As many as 20% of patients with penetrating chest injuries will have occult penetrating cardiac trauma.

• High index of suspicion: There should always be a high index of suspicion for cardiac injury in any patient with penetrating chest trauma, irrespective of clinical stability.

• TTE for stable patients: TTE should be performed in all of these patients to assess for the presence of pericardial effusion or hematoma.

• Late complication management: Trauma patients should be examined carefully several weeks after the injury. If a mechanical complication is suspected, it can be confirmed by echocardiography or cardiac catheterization.

7.1 Blunt Cardiac Injury Management

• Low risk: Hemodynamically stable patients with a normal ECG and normal serial troponin levels.

• Telemetry: Patients with an abnormal ECG, including those with conduction disturbances, and/or elevated troponin but normal echocardiogram.

• Duration: 24–48 h of telemetry monitoring.

• Operative correction: Patients with mechanical complications (acute valvular insufficiency, myocardial rupture).

• Resuscitation: Endotracheal intubation, large-bore intravenous access, immediate thoracotomy.

7.2 Penetrating Cardiac Injury Management

- Resuscitation: Endotracheal intubation, large-bore intravenous access.
- Thoracotomy: Immediate thoracotomy to allow for pericardial drainage and repair of cardiac injuries.
- Cross-clamping: Occasionally, cross-clamping of the descending aorta is required.
- Pericardiocentesis: Lifesaving in patients with tamponade but usually only a temporizing measure.
- Decortication: May be required for constriction.
- TTE: Should be performed in all patients with penetrating chest trauma to assess for pericardial effusion or hematoma.

8. PROGNOSIS & COMPLICATIONS

- Metastatic tumors: The response of cardiac sarcomas to these therapies is generally poor.
- Lymphosarcoma survival: Long-term survival achieved in ~40% of treated individuals.
- BCI rupture survival: Although generally fatal, up to 40% of patients with cardiac rupture have been reported to survive long enough to reach a specialized trauma center.
- Penetrating injury survival: Up to half of such patients may survive long enough to reach a specialized trauma center if immediate resuscitation is performed.
- Gunshot survival: Twenty percent of shooting victims survive.
- Knife survival: Up to 65% of stabbing victims survive.
- Aortic rupture prognosis: Aortic rupture into the left thoracic space is almost universally fatal.
- Commotio cordis survival: Survival depends on prompt defibrillation.
- Iatrogenic injuries prognosis: Associated with a better prognosis than are other forms of penetrating cardiac trauma.
- Constriction: Pericardial hemorrhage may predispose to the development of constriction.
- Arteriovenous fistulas: May develop, occasionally resulting in high-output heart failure.

8.1 Survival Rates

- Metastatic tumors: ~40% long-term survival for lymphosarcoma.
- BCI rupture: Up to 40% survive to reach trauma center.
- Penetrating injury: Up to 50% survive to reach trauma center.
- Gunshot: 20% survival.
- Knife: 65% survival.

8.2 Complications

- Myocardial rupture: Free wall rupture, ventricular septal rupture.
- Valvular insufficiency: Mitral, tricuspid, aortic valve.
- Coronary artery injury: Dissection, occlusion, laceration.
- Pericardial effusion and tamponade.
- Constriction: From pericardial hemorrhage.
- Arteriovenous fistulas: High-output heart failure.
- Commotio cordis: Ventricular fibrillation.

9. SPECIAL CONSIDERATIONS

• Iatrogenic injuries: Cardiac perforation of the right atrium, the RV free wall, or the interventricular septum may occur as a complication of cardiac procedures including placement of central venous/intracardiac catheters, insertion of pacemaker/defibrillator leads, or performance of RV endomyocardial biopsies.

• Coronary arterial perforation: Can occur during deployment of intracoronary stents.

• Commotio cordis: Occurs most often in adolescents during sporting events.

• Takotsubo syndrome: Sudden emotional or physical trauma, even in the absence of direct cardiac trauma, may precipitate a transient catecholamine-mediated cardiomyopathy.

• Aortic rupture: Rupture or transection of the aorta, usually just above the aortic valve or at the site of the tethering ligamentum arteriosum, is a common consequence of nonpenetrating chest trauma.

• Contained rupture: The rupture may occasionally be contained by the aortic adventitia, resulting in a false, or pseudo-, aneurysm that may be discovered months or years after the initial injury.

9.1 Iatrogenic Injuries

• Central venous/intracardiac catheters

• Pacemaker/defibrillator leads

• RV endomyocardial biopsies

• Intracoronary stents

9.2 Sports & Adolescents

• Commotio cordis: Adolescents during sporting events.

• Sports: Baseball, hockey, football, and lacrosse.

10. KEY PEARLS & CLINICAL TRAPS

• Rapid deceleration: May be associated with significant cardiac injury even in the absence of external signs of thoracic trauma.

• Normal troponin: Normal troponin level at 6–8 h after chest trauma essentially excludes BCI.

• Occult injury: As many as 20% of patients with penetrating chest injuries will have occult penetrating cardiac trauma.

• Gunshot vs Knife: Gunshot wounds are associated with a higher mortality than are knife wounds.

• Multichamber injury: Multichamber involvement carries a worse prognosis than single-chamber injury.

• Pericardiocentesis: Is a temporizing measure while awaiting definitive surgical therapy.

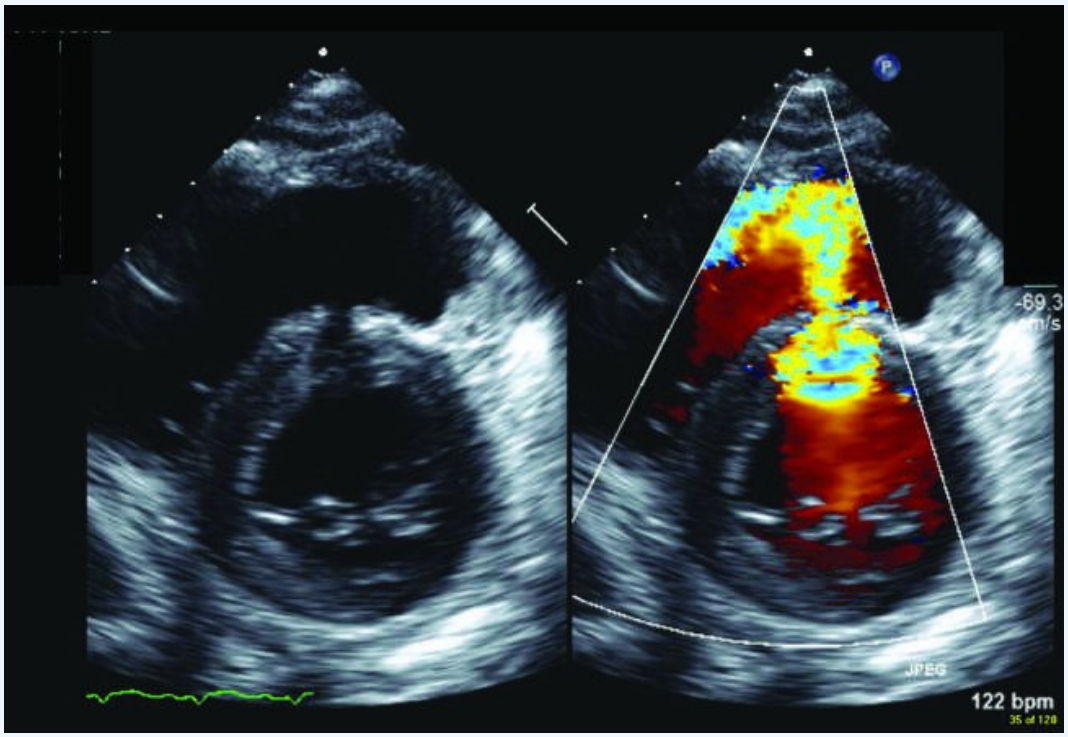
• Commotio cordis: Survival depends on prompt defibrillation.

• Aortic rupture: Aortic rupture into the left thoracic space is almost universally fatal.

• Chest pain: Often reflects musculoskeletal trauma rather than cardiac ischemia.

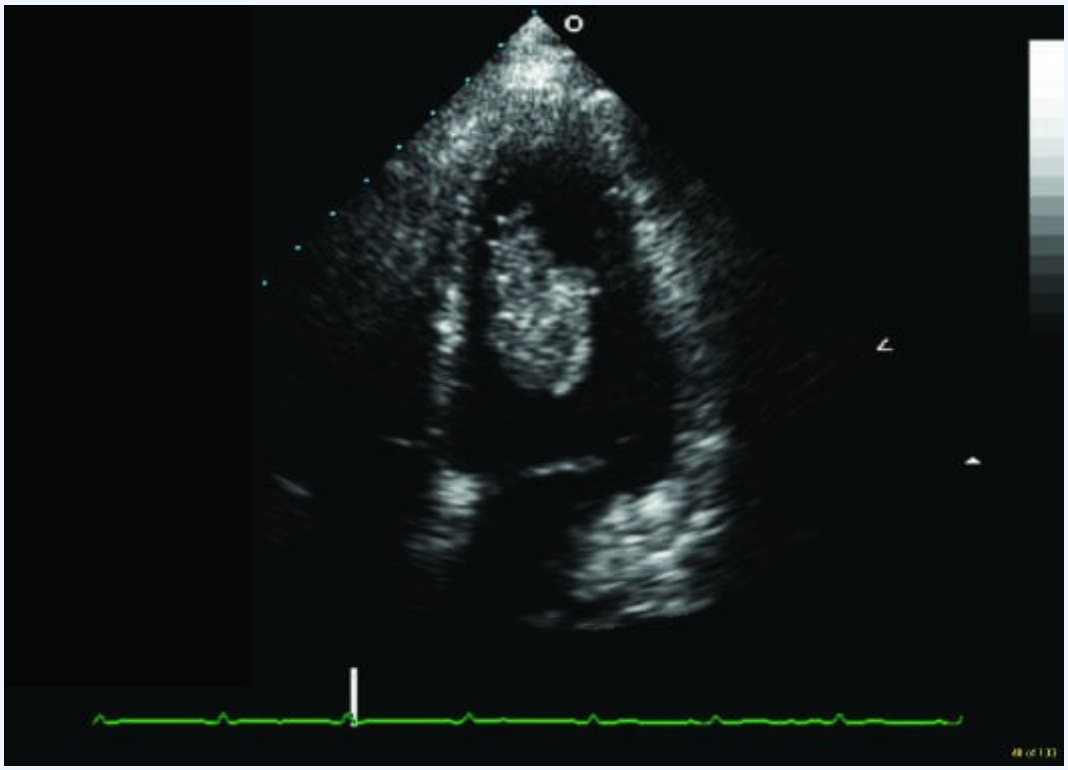
• Metastatic tumors: Cardiac metastases are clinically apparent only ~10% of the time.

FIGURES & ILLUSTRATIONS — FROM HARRISON'S



Harrison's 22e · Figure 1

FIGURE 283-1 Transthoracic echocardiogram demonstrating a traumatic ventricular a self-inflicted stab wound to the chest. Subsequent two-dimensional imaging (A) demonstrating prominent left-to-right shunting across the defect. LV, left ventricle; RV, — Large metastatic lesion (Met) in the left ventricle (LV) of a patient with diffusely metastatic bladder cancer. The mass arose from the interventricular septum and prolapsed into the aortic outflow tract during systole.



Harrison's 22e · Figure 2

FIGURE 282-4 Large metastatic lesion (Met) in the left ventricle (LV) of a patient with diffusely metastatic bladder cancer. The mass arose from the interventricular septum and prolapsed into the aortic outflow tract during systole. — Transthoracic echocardiogram demonstrating a traumatic ventricular septal defect. The patient underwent emergent repair of the right ventricle following a self-inflicted stab wound to the chest. Subsequent two-dimensional imaging revealed a laceration of the interventricular septum with color flow Doppler demonstrating prominent left-to-right shunting across the defect.

Harrison's 22e · Figure 3

FIGURE 282-4 Large metastatic lesion (Met) in the left ventricle (LV) of a patient with diffusely metastatic bladder cancer. The mass arose from the interventricular septum and prolapsed into the aortic outflow tract during systole. — Anatomical illustration depicting the mechanism of blunt cardiac injury, aortic rupture, or commotio cordis impact site as discussed in the context of deceleration trauma.