Blunt Cardiac Injury

Raeanna Adams, MD, MBA
Oscar Guillamondegui, MD, MPH

Editorial Review: Annie Moore MD

Niels Martin MD

Injury/Disease Demographics

- Blunt cardiac injury (BCI) is a broad spectrum of injury and can occur after any type of trauma to the chest, with true incidence unknown.
    - It is identified in 3-20% of patients with sternal fractures.
    - Frontal impact motor vehicle collisions are associated with 3 times increase in risk.
    - Thought to be a factor in 20% of deaths from motor vehicle collisions.
    - Head and spine injuries increase the risk 3.5 and 4.7 times, respectively.
- May occur due to direct injury, deceleration, blast/concussion, or crush injuries.
    - Deceleration more likely to lead to avulsion injuries or to valves, coronary arteries, etc.
    - Commotio cordis is cardiac arrest with sudden chest strike thought to coincide with ventricular repolarization, causing electrical disruption. It is an exception to the usual pattern of BCI, as it may not be associated with other obvious thoracic injury.
- All age groups can be affected by BCI.
    - Pediatric BCI may be less common but may be more difficult to diagnose due to increased chest wall compliance (thus less obvious chest wall injury).
- Right side cardiac injuries are more common than left.
- The most common blunt injury to cardiac valves is aortic, followed by mitral.

Clinical Presentation

- The presentation of BCI can range from asymptomatic to life-threatening hemodynamic instability.
    - Likely the most common presentation is local myocardial contusion due to direct injury and may present as troponin elevation or EKG changes.
- There are no standard criteria for screening patients, however patients with new onset arrhythmia other than mild sinus tachycardia should be screened.
- Blunt cardiac injury should be suspected in any patient with significant chest trauma and poor response to resuscitation and/or new arrhythmia.

Evaluation/Diagnostics/Imaging

- Patients in whom blunt cardiac injury is suspected should undergo an electrocardiogram (EKG).
    - The most common arrhythmias other than sinus tachycardia after blunt cardiac injury are premature ventricular contractions and bundle branch blocks.
- Measurement of troponin I can rule out the presence of blunt cardiac injury in patients not requiring admission for other injuries.
    - Troponin levels should not otherwise be ordered, as they are neither diagnostic nor prognostic.
    - Controversially, a single troponin level can be ordered to rule out massive elevation that may be indicative of a blunt coronary artery dissection. This is controversial as most blunt coronary artery dissections would be associated with other signs to prompt ordering the troponin such as EKG changes and chest pain.
    - Normal troponin I does not need to be repeated beyond eight hours from injury.

    - Creatinine kinase levels may be elevated in trauma, do not contribute to the diagnosis of blunt cardiac injury, and should not be ordered solely for that purpose.
- Transthoracic echocardiogram should be performed in patients with hemodynamic instability or persistent arrhythmias and is useful for evaluation of regional wall abnormalities and valvular evaluation. Transesophageal echocardiogram can provide improved images; however, it is a more invasive procedure.
- Cardiac-gated CT Angiography may be useful in identifying injuries, determining coronary artery patency, and determining myocardial function and perfusion. Cardiac CTA is less reliable in patients with significant tachycardia.
- Identification of an isolated sternal fracture should not prompt full investigation into BCI. Patients with isolated sternal fractures do not require an echocardiogram.

Role of Non-operative Management and Associated Considerations

- Patients with EKG abnormalities other than sinus tachycardia should be admitted for cardiac monitoring.
    - Patients should be monitored for 24 hours or until their troponin peak, whichever is greater duration
- Management of a hemodynamically significant arrhythmia without obvious structural abnormality is most commonly performed with vasopressor/inotropy, anti-arrhythmics, and volume management.
- Mitral valve injuries with significant regurgitation may require afterload reduction to avoid emergent operation.
- The use of intra-aortic balloon pump has been described in patients with hemodynamically significant myocardial contusions with cardiac dysfunction.
- Injury to the coronary arteries is extremely rare; as such, there is limited utility in cardiac catheterization. This should be reserved for patients in whom coronary artery pathology is highly suspected based on EKG, TTE, or Cardiac CTA. Catheterization with stenting may be useful for coronary dissection, thrombosis, or spasm. Use of antiplatelet or thrombolytic agents should take other injuries into consideration.

Treatment of Blunt Cardiac Injury (grading=AAST)		
Grade	**Injury/Signs**	**Treatment**
Grade I	Minor EKG abnormality (nonspecific ST or T wave changes, PAC or PVCs or persistent sinus tachycardia)	Most commonly, only monitoring
	Blunt pericardial wound without cardiac injury, tamponade, or cardiac herniation	
Grade II	Heart block or ischemic changes without failure	May need pacing, appropriate volume and inotropic management
Grade III	Sustained or multifocal ventricular contractions	+/- hemodynamic support, monitoring
	Septal rupture, pulmonary or tricuspid incompetence, papillary muscle dysfunction, or distal coronary artery occlusion without cardiac failure	Options: operative/interventional, hemodynamic support, as relevant
	Blunt cardiac laceration with cardiac herniation	Operative
	Blunt cardiac injury with cardiac failure	Medical management, possible IABP
Grade IV	Septal rupture, pulmonary or tricuspid incompetence, papillary muscle dysfunction, or distal coronary artery occlusion producing cardiac failure	Operative/interventional, hemodynamic support
	Aortic or mitral valve incompetence	
	Injury of the right ventricle, right or left atrium	
Grade V	Proximal coronary artery occlusion	Intervention/operative, often fatal
	Left ventricular perforation	
	Stellate injuries, <50% tissue loss of the right ventricle, right or left atrium	
Grade VI	Blunt avulsion of the heart	Operative, likely fatal

Blunt cardiac injury grading extracted from the AAST Heart Injury grading scale. https://www.aast.org/resources-detail/injury-scoring-scale#heart accessed 02.22.2022

Indications for Operative Intervention

- Evidence of cardiac tamponade on FAST exam requires emergent operation.
    - Caution should be used in interpreting FAST in the setting of massive hemothorax which can mask the presence of pericardial effusion if the pericardium is injured.
- Hemodynamically unstable patients with evidence of anatomic abnormalities or flow abnormalities should be considered for intervention.
    - Valvular disruptions are the most common intracardiac injury followed by cardiac rupture.
    - The most common blunt cardiac rupture is of the right atrium.
- Blunt cardiac injuries requiring surgical repair are rare, accounting for less than 0.01% of all trauma cases and up to 3% of all blunt chest trauma cases.
    - Shunt fraction should be measured in traumatic VSD. Patients with shunt fraction greater than 2:1 (pulmonic to systemic) should undergo operative repair. Patients with lower shunt fraction may be considered for nonoperative management. Catheter-based repair techniques may be possible depending on injury type and local resources.
    - Injury to the mitral valve area is most common to the papillary muscle rather than the valve leaflets. This frequently necessitates mitral valve replacement and most commonly presents as acute heart failure.
    - Injury to the aortic valve requiring surgical intervention most commonly presents as a new onset of aortic regurgitation and should be evaluated for an aortic valve replacement.
- While the trauma surgeon should feel prepared to repair lacerations and ruptures of the heart muscle, valvular and septal injuries requiring opening the heart and/or cardiopulmonary bypass should prompt rapid consultation with cardiac surgery.

Pre-operative Preparation

- Patients with evidence of cardiac tamponade should have volume resuscitation prior to and during intubation, as induction of anesthesia will cause a loss of vasomotor tone and may precipitate arrest.
- Patients with suspected blunt cardiac injury requiring operative intervention should be prepped from chin to knees in case vein conduit is required for proper repair, e.g., bypass of an injured coronary.
    - Only injuries to the proximal to middle segments of the coronary arteries should be considered for bypass
    - Early mobilization of a perfusion team and cardiopulmonary bypass machine should be completed when planning operative repair of the heart for trauma.

Impact of Associated Injuries

- Special attention should be paid to the presence of concomitant injuries precluding the use of anticoagulants, such as traumatic brain injury, which may occur in as many as 35% of patient with blunt cardiac injury.
- Blunt cardiac rupture has a uniformly poor prognosis with up to 97% in field mortality rate
- Only 35% of blunt cardiac rupture injuries who survive transport to the hospital will make it to the operating room
    - Atrial injuries have relatively favorable outcomes.
    - Ventricular injury is associated with poor outcomes. Left ventricular rupture may be associated with up to 30% of prehospital deaths.
- Bichamber injuries and complete rupture with pericardial avulsion are associated with near 100% fatality; only scattered case reports of survival punctuate the literature.

Operative Techniques/Intraoperative Considerations

- Patients presenting with evidence of cardiac tamponade should be rapidly transported; airway management should be performed in the OR with ongoing volume resuscitation.
- The preferred approach for management of tamponade is addressed in a separate module.
- If injuries can be identified, there are multiple temporizing maneuvers that can be used including:
    - digital occlusion
    - direct suture repair using a horizontal mattress technique (consider use of pledgets)
    - application of a Satinsky clamp
    - Foley balloon tamponade
    - stapling with a skin stapling device to approximate the defect
- When an injury occurs near a coronary artery, horizontal mattress sutures should be used, and ligation of the artery should be avoided if possible.
- If rapid operative intervention precluded preoperative imaging, there should be a high index of suspicion for intra-cardiac lesions as well (septal rupture or valvular dysfunction). Intra-operative TEE should be considered in the appropriate setting.

Postoperative Management/Complications

- The phenomenon of delayed cardiac rupture has been described up to two weeks after injury. This is presumed to be due to either aneurysm formation, or contained atrial rupture e.g., pseudoaneurysm.
- Though rare injuries, Valvular or septal injuries managed nonoperatively need echocardiography monitoring to rule out worsening.

Considerations for Special Populations

- In elderly patients with significant thoracic trauma, underlying coronary artery disease, elevated troponin, and arrhythmia where myocardial infarction cannot be excluded, multi-slice CT or MRI may be useful in centers with expertise to identify contusion rather than ischemic injury. This is not typically useful in workup otherwise.
- Swan-Ganz catheters can provide additional information in patients with known cardiac

disease or known blunt cardiac injury who are unstable requiring operative or non-operative management. This has decreased in use with increased use of echocardiography for serial evaluation.

- The difficulties with diagnosing blunt cardiac injuries in adults are mirrored in the pediatric population, with the additional factor that pediatric patients may not demonstrate the severity of traumatic impact, due to chest wall compliance.
- In pediatric patients, the most common EKG abnormality is a bundle branch block, right greater than left.
- Up to five percent of pediatric patients surviving blunt cardiac injury will have long-term cardiac sequelae involving tricuspid regurgitation or ventricular septal defect.

Suggested Readings

- Joseph B et al., Identifying the broken heart: predictors of mortality and morbidity in suspected blunt cardiac injury. Am J Surg, 2016;211(6):982-8.
- Velmahos GC et al., Normal electrocardiography and serum troponin I levels preclude the presence of clinically significant blunt cardiac injury. J Trauma, 2003;54(1):45-50; discussion 50-1.
- Clancy K et al., Screening for blunt cardiac injury: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg, 2012;73(5 Suppl 4): S301-6.
- Gregorian A, et al. National risk factors for blunt cardiac injury: Hemopneumothorax is the strongest predictor. Am J Surg. 2019 Apr;217(4):639-642.
- Nair L, Winkle B, Senanayake E. Managing blunt cardiac injury. J Cardiothorac Surg. 2023 Feb 10;18(1):71.
- https://www.aast.org/resources-detail/blunt-cardiac-injury accessed 02.22.2022