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BLUNT CARDIAC TRAUMA

Evidence Based Medicine Guideline

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SUMMARY
Blunt cardiac injury (BCI) is uncommon and varies in clinical significance. When clinically significant, it carries substantial morbidity and mortality. Screening includes electrocardiography (ECG) and troponin I levels in those patients with blunt thoracic trauma. Patients with negative screening can be safely discharged home in the absence of other injuries. Echocardiography plays a role in the evaluation of new onset arrhythmias, hypotension, or heart failure. A troponin I greater than 1 ng/mL is associated with BCI.

RECOMMENDATIONS

- **Level 1**
  - **All patients with blunt thoracic trauma should receive an ECG and troponin I level to screen for BCI.**
- **Level 2**
  - **Patients with normal ECG and troponin I after 8 hours can safely be discharged in the absence of other injuries requiring admission.**
  - **An echocardiogram should be obtained in patients with a troponin I > 1 ng/ml.**
- **Level 3**
  - **Patients with an abnormal ECG or troponin I should undergo echocardiogram only in the presence of hypotension, new arrhythmia, or heart failure.**
  - **Patients with known BCI should be monitored for at least 24 hours in an intensive care unit or on a telemetry floor.**
  - **Patients with BCI should undergo heart failure screening 3-6 months post-injury.**

INTRODUCTION

Blunt cardiac injury (BCI) occurs in 2.3-4.6% of trauma patients (1,2) with an overall mortality of 11.4-24.5%. An autopsy-based review by Turan et al. demonstrated 20% percent of all motor vehicle collisions (MVC) postmortem have evidence of BCI (2). Other studies have suggested that the incidence of BCI following severe blunt thoracic or polytrauma may be as high as 76%. The difficulty in establishing the true incidence of BCI is not within the testing itself but the screening of patients who may have the condition. BCI has a wide spectrum of clinical significance from no effect on the patient's overall condition to life threatening requiring intervention. A formalized definition is needed to further analyze BCI and the development of a treatment algorithm.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

LITERATURE REVIEW

Primary Cause of Death

The most common causes of immediate death from BCI are as follows: cardiac chamber rupture (64%), venous-atrial confluence tears (33%), coronary artery tear or dissections (3%) (3). The majority of severe blunt cardiac injuries result in immediate death leaving only mild to moderate BCI cases to present to a trauma center.

Physics of Injury

BCI most generally occurs from a direct blow at maximal distention at the end of diastole. Indirect injury is the result of a traumatic increase in preload by way of abdominal or extremity vein compression that causes a damaging increase in intracardiac pressure. This phenomenon is known as the "hydraulic ram effect" making the heart susceptible to rupture. "Bidirectional force" is the compression of the heart between the spine and sternum. Deceleration injuries result in valvular, myocardial, or coronary artery tears. Other injury patterns resulting in BCI are blast, crush, concussive, or a combination of the above injury mechanisms (4).

BCI Categories

BCI can be divided into two groups: structural cardiac injury or electrical disturbances. Structural injuries most commonly include intramural hematomas (IMH) involving the right ventricle due to its anterior position in the heart. IMH can result in transient bundle branch blocks (BBB), premature ventricular contractions (PVC), and rarely in persistent BBB, bifascicular blocks, or complete heart block. Treatment is generally supportive with resolution in 4-12 weeks (3).

Valvular injuries in BCI are most commonly the result of papillary muscle rupture causing valvular regurgitation. The valvular structures in order of frequency of injury are papillary muscle, chordae, and mitral leaflets. Among 82 reported cases of BCI, 56% required valve replacement (5). The tricuspid valve is often a missed injury presenting as regurgitation months to years later.

Ventricular septal rupture, if large, may require repair due to development of an anatomic shunt. Transcatheter based repairs have been reported in the literature since 2004.

Coronary artery injury is the result of direct compression, dissection, thrombosis, or a combination of all three. The left anterior descending and left main coronary artery are most susceptible. Intimal tears resulting in distal thrombosis have been managed by percutaneous coronary intervention although some advocates recommend bypass. TPA is contraindicated in most trauma patients but reports of its use do exist in the literature.

Myocardial infarction, if not the direct result of persistent coronary artery ischemia, is generally transient and wall motion abnormalities may be seen on echocardiogram.

Electrical disturbances most commonly are mild sinus. Atrial arrythmias occur less than 2% of the time. Ventricular dysrhythmias, most commonly PVCs, are poorly understood for their clinical significance. Conduction disturbances are generally the result of an IMH and are transient.

Associated Injuries

The most common injuries associated with BCI are fractures of the ribs, sternum, spine, traumatic aortic injuries, hemothorax, and pneumothorax. Recent data by Grigorian et al. demonstrate that hemopneumothorax has the highest association followed by sternal fracture and esophageal injury (6). Of note, their study of 15,976 patients also noted an association with a history of myocardial infarction and angina within the last 30 days (6). Heidelberg et al. identified among 235 patients with BCI that the presence of a severely displaced sternal fracture, retrosternal hematoma, or distance of displacement had no significant association with the diagnosis of BCI after adjusting for age, gender, and injury severity scale (ISS) (7).

Screening for Blunt Cardiac injury

ECG alone has a negative predictive value of 95%. The addition of a normal serum troponin I with a normal ECG affectively rules out BCI with a negative predictive value approaching 100%. Patients with abnormal ECGs or elevated troponin I levels should be admitted to observation although the exact duration of monitoring is poorly understood (8,9).

Arrhythmias
Positive ECG findings in BCI include sinus tachycardia, conduction abnormalities, ST segment changes, T wave inversion, and arrhythmias. Sinus tachycardia is the most common ECG abnormality in both trauma patients and those with BCI. Other arrythmias are present only 1-6% of the time. The second most common arrythmia is atrial fibrillation with a series of 240 patients reporting an incidence of only 4% (10,11). Atrial fibrillation may not be due to direct cardiac injury as the incidence of atrial fibrillation is the same in patients with head and abdominal trauma as it is in chest trauma. Patients with atrial fibrillation and rapid ventricular response with hemodynamic compromise should be cardioverted. Asymptomatic atrial fibrillation should be considered for beta-blocker or calcium channel blocker with consideration for delayed elective cardioversion (12).

Supraventricular tachycardia is exceedingly rare and its incidence in BCI is unknown. The treatment is adenosine, beta-blockers, or cardioversion. Right BBB generally has no long-term complications and leads to no difference in functional outcome. Most ECG abnormalities with regards to BCI are of no clinical consequence and are transient (10-12).

Troponin I
The three isoforms of troponin I are cTnI (cardiac), ssTnI (slow skeletal muscle), and fsTnI (fast skeletal muscle). The recent investigational use of ssTnI in the presence of significant skeletal muscle damage and no cardiac injury may demonstrate a utility for the comparison of skeletal muscle TnI and cardiac TnI in the diagnosis of BCI (13). Heart-type fatty acid-bind proteins (H-FABPs), a new biomarker for myocardial ischemia which can be detected 30 minutes after the onset of cardiac insult, has been investigated in a limited capacity for blunt thoracic trauma, but has not been found to have a significant association with BCI (9).

The significance of Troponin I elevation is difficult as no formal definition of BCI exists. Of six studies pooling 213 patients with a troponin of > 0.04 ng/mL, 49% had echocardiogram evidence of BCI (8,14-17). Mori et al. and Rajan et al. found 60-70% of patients with echocardiogram confirmed BCI had a TnI > 1 ng/mL (15,16).

Echocardiography
Transthoracic echocardiogram is considered the ideal imaging initial tool for BCI. Echocardiography should be obtained when unexplained hypotension in present or resuscitation out of proportion to injuries is required. A study by Chirillo et al. compared transthoracic (TEE) with transesophageal echocardiography (TEE) in the identification of serious injuries including wall and valvular rupture and found a sensitivity of 60% for TTE and 98% for TEE (18).

Cardiac Computed Tomography Angiography and Cardiac Magnetic Resonance Imaging
Cardiac computed tomography angiography (Cardiac CTA) is useful for evaluation of coronary patency with the consideration for compression, occlusion, and dissection. The use of a triple phase protocol can assist in ruling out aortic injury and pulmonary artery injury. Cardiac CTA is useful for younger patients that do not have calcified coronary arteries. Cardiac CTA reduces the incidence of cardiac catheterization which is important in trauma patients as they are generally not candidates for systemic anticoagulation. Cardiac CTA becomes less reliable in patients with moderate to severe tachycardia and calcified vessels (19,20). Cardiac Magnetic Resonance Imaging (Cardiac MRI) is useful with late phase gadolinium enhancement in the evaluation of IMH but is not indicated in unstable patients (21).

Follow Up
The exact incidence of late term complications is not well understood. Case reports exist of complete atrioventricular block, delayed cardiac rupture, heart failure, coronary-to-pulmonary artery fistula, pericardial effusion, coronary artery occlusion, and constrictive pericarditis. A study by Amino et al. of eleven patients surveyed 12 months after BCI with 24-hour Holter monitor and cardiac nuclear medicine showed 33% had cardiac abnormalities of either ventricular tachycardia or perfusion abnormalities. More comprehensive studies of blunt cardiac injury are needed to understand the true long-term sequela of BCI (22).

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