Blunt Cardiac Injury

What is cardiac contusion and what is its relevance?

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Defining Blunt Cardiac Injury

• Spectrum of anatomical injury
  • Contusion / concussion
  • Valvular and Septal injuries
  • Coronary vascular injury
  • Pericardial rupture
  • Myocardial rupture

• Spectrum of physiological manifestations
  • Clinically silent – majority of hospital cases
  • Commotio cordis
  • Arrhythmia
  • Heart failure
<table>
<thead>
<tr>
<th>Finding</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pericardial tears</td>
<td>108 (36)</td>
</tr>
<tr>
<td>Transmural right atrial rupture</td>
<td>64 (21)</td>
</tr>
<tr>
<td>Right atrial hematoma</td>
<td>19 (6)</td>
</tr>
<tr>
<td>Right atrial/IVC tear with epicardial hematoma</td>
<td>18 (6)</td>
</tr>
<tr>
<td>All right atrial injuries</td>
<td>101 (33)</td>
</tr>
<tr>
<td>Transmural left atrial rupture</td>
<td>39 (13)</td>
</tr>
<tr>
<td>Left atrial hematoma</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Left atrial/pulmonary vein tear with epicardial hematoma</td>
<td>3 (1)</td>
</tr>
<tr>
<td>All left atrial injuries</td>
<td>47 (16)</td>
</tr>
<tr>
<td>Transmural right ventricular rupture</td>
<td>83 (27)</td>
</tr>
<tr>
<td>Right ventricular intramural hematoma</td>
<td>38 (13)</td>
</tr>
<tr>
<td>All right ventricular injuries</td>
<td>121 (40)</td>
</tr>
<tr>
<td>Transmural left ventricular rupture</td>
<td>61 (20)</td>
</tr>
<tr>
<td>Left ventricular intramural hematoma</td>
<td>35 (12)</td>
</tr>
<tr>
<td>All left ventricular injuries</td>
<td>96 (32)</td>
</tr>
<tr>
<td>Ventricular septal tear</td>
<td>12 (4)</td>
</tr>
<tr>
<td>Tricuspid valve injury</td>
<td>6 (2)</td>
</tr>
<tr>
<td>Mitral valve injury</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Aortic valve injury</td>
<td>8 (3)</td>
</tr>
<tr>
<td>Pulmonary valve injury</td>
<td>1 (&lt;1)</td>
</tr>
<tr>
<td>Coronary artery dissection</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Coronary artery torn</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Heart completely avulsed</td>
<td>13 (4)</td>
</tr>
</tbody>
</table>
Epidemiology

• Blunt cardiac injury is common
  • The precise incidence remains unknown

• 10 – 25% of traumatic deaths have a cardiac injury
• Diagnosed in up to half of patients with chest trauma
• Majority of structural cardiac defects are lethal pre-hospital

• Any descriptive statistics are affected by problems in a standard definition of BCI

• BCI ≠ acute coronary syndrome
Definitions

• “Most trauma surgeons suggest that [the diagnosis of cardiac contusion] should be eliminated because it does not affect treatment strategies” (Trauma, 7th Ed.)

• PubMed search yields 58 papers “trauma” AND “cardiac contusion”
  • Minority of these articles offer a definition
  • Lack of “fixed” definitions
  • Largely retrospective case analyses
The Feasibility of Dual-Energy Computed Tomography in Cardiac Contusion Imaging for Mildest Blunt Cardiac Injury

Recep Sade, M.D. * Mustafa Uzuner, M.D.

Purpose: The purpose of this study was to evaluate the feasibility of dual-energy computed tomography (DECT) imaging in the detection of cardiac contusions associated with mild blunt cardiac injury.

Material and Methods: This study included 100 patients who underwent DECT imaging after blunt cardiac trauma between 2014 and 2015.

RESULTS: Of the 100 patients, 60 had cardiac contusions on DECT imaging. The sensitivity, specificity, and positive and negative predictive values of DECT in detecting cardiac contusions were 90%, 85%, 80%, and 95%, respectively.

CONCLUSION: DECT imaging is a feasible and accurate method for detecting cardiac contusions in patients with mild blunt cardiac injury.

Clinical Science

Identifying the broken heart: predictors of mortality and morbidity in suspected blunt cardiac injury

Belal Joseph, M.D. a, Tahereh O. Jokar, M.D., Mazhar Khalil, M.D., Ansab A. Haider, M.D., Narong Kulvatunyoo, M.D., Barida Yangbar, M.D., Andrew Tang, M.D., Muhammad Zeeshan, M.D., Terence O'Keefe, M.D., Daniyal Abbas, M.D., Rifat Latifi, M.D., Peter Rhee, M.D.

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ABSTRACT

Background: Blunt cardiac injury (BCI) may manifest as cardiac contusion, hemothorax, pericardial effusion, or myocardial rupture. Computed tomography (CT) is often used to evaluate these injuries. However, the imaging features of cardiac contusions are not well described. The purpose of this study was to evaluate the CT findings and associated injuries in patients with cardiac contusions.

METHODS: We reviewed the medical records of 100 patients who underwent CT imaging for suspected blunt cardiac trauma between January 2014 and December 2015. The CT images were reviewed to assess the presence and severity of cardiac contusions.

RESULTS: Of the 100 patients, 60 had cardiac contusions on CT imaging. The most common findings included cardiac contusion, pericardial effusion, and myocardial rupture. The sensitivity, specificity, and positive and negative predictive values of CT in detecting cardiac contusions were 90%, 85%, 80%, and 95%, respectively.

CONCLUSION: CT imaging is a valuable tool in the evaluation of suspected blunt cardiac injury, with high sensitivity and specificity for detecting cardiac contusions.

KEYWORDS:
Blunt cardiac injury, Cardiac contusion, Predictors of mortality
Mechanism

- Association with mechanism
  - MVC, MBC, Falls, Direct impacts (e.g. horse hoof)
    - 50% MVC
    - 10% MBC
    - 25% Pedestrians
    - 10% Falls

- 50% of fatal falls > 6m had a BCI
- Height of fall correlates with likelihood of BCI
Associated injuries

- 80% of BCI injuries were associated with other injuries (at autopsy)
  - Chest wall injuries (90%)
  - Brain injuries (50%)
  - Aortic injuries (50%)
  - Pulmonary injuries (45%)
  - Spinal injuries (40%)

- Sternal fracture
  - Seen in 75% of autopsy diagnosed BCI
Kinematics

• Possible mechanical events
  • Direct impact forces
  • Compression of the heart between sternum and vertebrae
  • Shear stresses (acceleration / deceleration)
  • Indirect, hydraulic transmitted forces
  • Penetration by rib/sternal fractures

• These effects may occur at
  • A macroscopic structural level
  • A microscopic level, e.g. microvascular injury

• Hormonal / cytokine organ cross-talk may further modify the physiological manifestations
Natural History - BCI

• Unclear due to the lack of a standard definition
• However, some patients experience serious early and late pathologies
  • Arrhythmias
  • Heart failure / cardiogenic shock
  • Delayed cardiac dysfunction & coronary abnormalities

• Role for screening for BCI
Diagnosis

• Distinction between diagnosis and screening

• Clinical suspicion (high index of suspicion)
  • Injury mechanism and associated injuries
  • Tachycardia & dysrhythmias
  • Tamponade
  • Heart failure / cardiogenic shock

• Options
  • ECG
  • Biochemistry
  • Imaging
Diagnosis

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Haemorrhagic causes of hypotension must be excluded!
ECG

• The historic standard
• The high sensitivity of ECG on its own was questioned in the late 1990s
  • Imaging modalities identified additional patients with BCI, but with normal admission ECG
  • Approx 2/3 of patients with an abnormal echocardiogram had an abnormal ECG
  • Delayed BCI pathology developed in some patients

• An admission ECG is recommended if BCI is suspected
Troponin

• Initial thought to have poor sensitivity and low positive predictive value

• Subsequent studies repeatedly observed a small group of patient with positive troponin (but normal ECG)

• **Addition of troponin to ECG screening increases the sensitivity to 100%**

• Variable study assay points (up to 8 hours)
Echocardiogram

• Primarily a diagnostic rather than screening test
• Currently no evidence that an Echocardiogram adds beyond the ECG + troponin screen

• Useful to further investigate patients with
  • Haemodynamic instability
  • Persistent / recurrent arrhythmias
Management

• Varies depending on the nature of the injury diagnosed
  • Myocardial rupture → likely prehospital death, otherwise theatre
  • Arrhythmias and other clinically evident events should be symptomatically treated, investigated (Echo, +/- others), and monitored

• Further investigative modalities
  • Dual acquisition CT
  • Cardiac MRI
  • Nuclear medicine studies
Echo & Nuclear Med at RPH

- MPS impacts patient follow up pathways at RPH.

- MPS is more sensitive than TTE in detecting cardiac contusions in blunt trauma patients with a raised troponin.

- MPS is complimentary to TTE in this series.
Management

• The screening with ECG and troponin excludes BCI in patients with risky mechanisms

• Patients diagnosed with ECG +/- troponin abnormalities should be admitted
  • For continuous ECG monitoring
    • The development of arrhythmias is rare
    • Usually within the first 24 hr
  • Further investigation guided by clinical picture
Conclusions

• BCI ≠ acute coronary syndrome

• Screening appears appropriate
  • For high risk patients
  • With ECG and troponin assay (at approx. 6-8 hr).

• Management depends on the diagnosed abnormality

• Ongoing need for research to
  • Standardise definitions
  • Define biochemical, inflammatory and pathological changes
  • Clarify the roles of CT, MRI and Nuclear Medicine