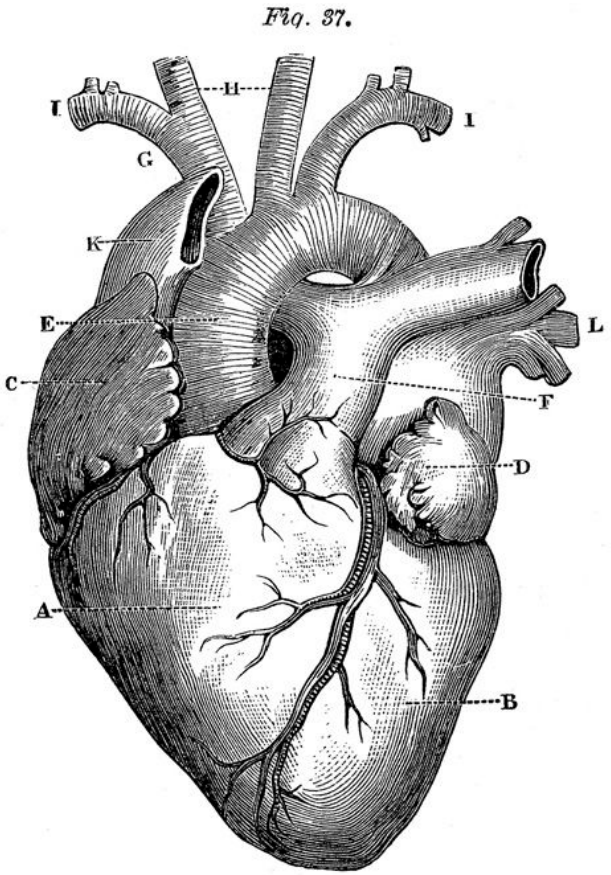
Blunt Cardiac Injury

What is cardiac contusion and what is its relevance?



Dieter G. Weber

FRACS

Trauma and General Surgeon

Head of Department, General Surgery

Royal Perth Hospital

Injury 2018

Auckland

2 August, 2018

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 1. Autopsy Findings in 303 Blunt Cardiac Injuries[a]

Finding	No. (%)
Pericardial tears	108 (36)
Transmural right atrial rupture	64 (21)
Right atrial hematoma	19 (6)
Right atrial/IVC tear with epicardial hematoma	18 (6)
All right atrial injuries	101 (33)
Transmural left atrial rupture	39 (13)
Left atrial hematoma	5 (2)
Left atrial/pulmonary vein tear with epicardial hematoma	3 (1)
All left atrial injuries	47 (16)
Transmural right ventricular rupture	83 (27)
Right ventricular intramural hematoma	38 (13)
All right ventricular injuries	121 (40)
Transmural left ventricular rupture	61 (20)
Left ventricular intramural hematoma	35 (12)
All left ventricular injuries	96 (32)
Ventricular septal tear	12 (4)
Tricuspid valve injury	6 (2)
Mitral valve injury	5 (2)
Aortic valve injury	8 (3)
Pulmonary valve injury	1 (<1)
Coronary artery dissection	3 (1)
Coronary artery torn	5 (2)
Heart completely avulsed	13 (4)

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

Injury, Int. J. Care Injured 48 (2017) 1013–1019

Contents lists available at Science

Injury

journal homepage: www.elsevier.com

Cardiac magnetic resonance imaging in suspected
A prospective, pilot, cohort study

Aidan JC Burrell[a,b,*], David M Kaye[c,d], Mark C Fitzgerald[e], Davic
James L Hare[c,d], Benedict T Costello[d], Andrew J Taylor[c,d]

[a] The Intensive Care Unit, Alfred Hospital, 55 Commercial Road, Melbourne 3181, VIC, Australia
[b] Australian and New Zealand Intensive Care Research Centre (ANZIC-RC), Department of Epidemiology and Pre
Alfred Centre, 99 Commercial Road, Melbourne 3004, VIC, Australia
[c] The Department of Cardiovascular Medicine, Alfred Hospital, 55 Commercial Road, Melbourne 3181, VIC, Austr
[d] BakerIDI Heart and Diabetes Institute, Melbourne, Australia
[e] The Departmen

ARTICLE

Keywords:
Blunt cardiac in
Cardiac contusi
Thoracic trauma
Echocardiograph
Cardiac imaging
Cardiac magneti

ORIGINAL ARTICLE

The Feasibility of Dual-Energy Computed Tomography in Cardiac Contusion Imaging for Mildest Blunt Cardiac Injury

Recep Sade, MD, Mecit Ka*
Mustafa Uzkeser, MD,

Purpose: The purpose of this study was to
feasibility of dual-energy computed tomograph
nosis of cardiac contusion with the mildest blu
Material and Methods: This study was p
2014 and September 2015; a total of 17 co

Injury, Int. J. Care Injured 47 (2016) 1025–1030

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Imaging in blunt cardiac injury: Computed tomographic findings in cardiac contusion and associated injuries

Mark M. Hammer[a,1], Demetrios A. Raptis[a], Kristopher W. Cummings[b], Vincent M. Mellnick[a], Sanjeev Bhalla[a], Douglas J. Schuerer[c], Constantine A. Raptis[a,*]

[a] Mallinckrodt Institute of Radiology, Washington University in St. Louis, St. Louis, MO, United States
[b] Department of Radiology, Mayo Clinic Arizona, Phoenix, AZ, United States
[c] Department of Surgery, Washington University in St. Louis, St. Louis, MO, United States

ARTICLE INFO

Article history:
Accepted 5 November 2015

Keywords:
Trauma
Blunt cardiac injury
Myocardial contusion
Cardiac contusion
Computed tomography

ABSTRACT

Background: Blunt cardiac injury (BCI) may manifest as cardiac contusion or, m
or myocardial rupture. Computed tomography (CT) is performed in the vast m
patients, but the imaging features of cardiac contusion are not well describe
Purpose: To evaluate CT findings and associated injuries in patients with clin
Materials and methods: We identified 42 patients with blunt cardiac injur
electronic medical record. Clinical parameters, echocardiography results, an
recorded. Two blinded reviewers analyzed chest CTs performed in these
hypoenhancement and associated injuries.
Results: CT findings of severe thoracic trauma are commonly present in patient
patients with ECG, cardiac enzyme, and echocardiographic evidence of BCI had a
or pericardium on CT; 73% had anterior rib fractures, and 64% had pulmo
fractures were only seen in 36% of such patients. However, myocardial hypoenh
sensitive for those patients with cardiac contusion: 0% of right ventricular co
ventricular contusions seen on echocardiography were identified on CT.
Conclusion: CT signs of severe thoracic trauma are frequently present in patie
should be regarded as indirect evidence of potential BCI. Direct CT findings of m
myocardial hypoenhancement, are poorly sensitive and should not be used as a
some left ventricular contusions can be seen on CT, and these patients could un
or cardiac MRI to evaluate for wall motion abnormalities.

© 2015 Elsevier

The American Journal of Surgery (2016) 211, 982-988

The American Journal of Surgery

Clinical Science

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

Bellal Joseph, M.D.*, Tahereh O. Jokar, M.D., Mazhar Khalil, M.D., Ansab A. Haider, M.D., Narong Kulvatunyou, M.D., Bardiya Zangbar, M.D., Andrew Tang, M.D., Muhammad Zeeshan, M.D., Terence O'Keeffe, M.D., Daniyal Abbas, M.D., Rifat Latifi, M.D., Peter Rhee, M.D.

Division of Trauma, Critical Care, Emergency Surgery, and Burns, Department of Surgery, University of Arizona, Tucson, AZ, USA

KEYWORDS:
Blunt cardiac injury;
Cardiac contusion;
Predictors of mortality

Abstract

BACKGROUND: Blunt cardiac injury (BCI) is an infrequent but potentially fatal finding in thoracic trauma. Its clinical presentation is highly variable and patient characteristics and injury pattern have never been described in trauma patients. The aim of this study was to identify predictors of mortality in BCI patients.

METHODS: We performed an 8-year retrospective analysis of all trauma patients diagnosed with BCI at our Level 1 trauma center. Patients older than 18 years, blunt chest trauma, and a suspected diagnosis of BCI were included. BCI was diagnosed based on the presence of electrocardiography (EKG), echocardiography, biochemical cardiac markers, and/or radionuclide imaging studies. Elevated troponin I was defined as more than 2 recordings of greater than or equal to .2. Abnormal EKG findings were defined as the presence of bundle branch block, ST segment, and *t*-wave abnormalities. Univariate and multivariate regression analyses were performed.

RESULTS: A total of 117 patients with BCI were identified. The mean age was 51 ± 22 years, 65% were male, mean systolic blood pressure was 93 ± 65, and overall mortality rate was 44%. Patients who died were more likely to have a lactate greater than 2.5 (68% vs 31%, $P = .02$), hypotension (systolic blood pressure < 90) (86% vs 14%, $P = .001$), and elevated troponin I (86% vs 11%, $P = .01$). There was no difference in the rib fracture (58% vs 56%, $P = .8$), sternal fracture (11% vs 21%, $P = .2$), and abnormal EKG (89% vs 90%, $P = .6$) findings. Hypotension and lactate greater than 2.5 were the strongest predictors of mortality in BCI.

Mechanism

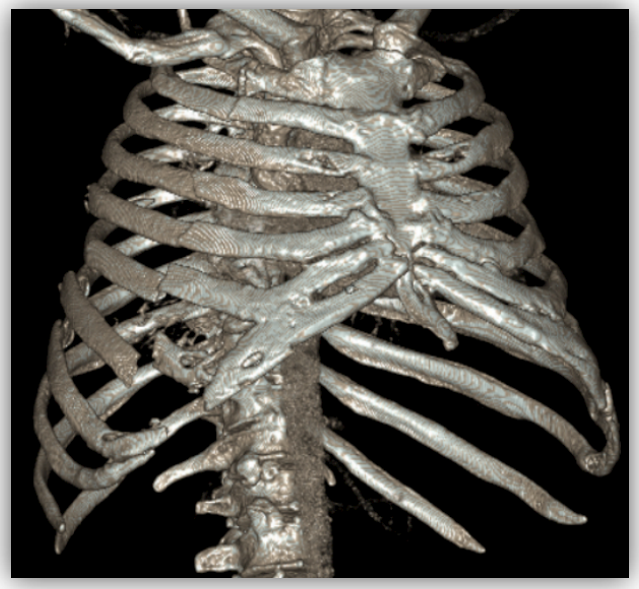
- Association with mechanism
  - MVC, MBC, Falls, Direct impacts (e.g. horse hoof)

  - 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


20 32
Advanced Life Support
for Adults

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

- 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

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

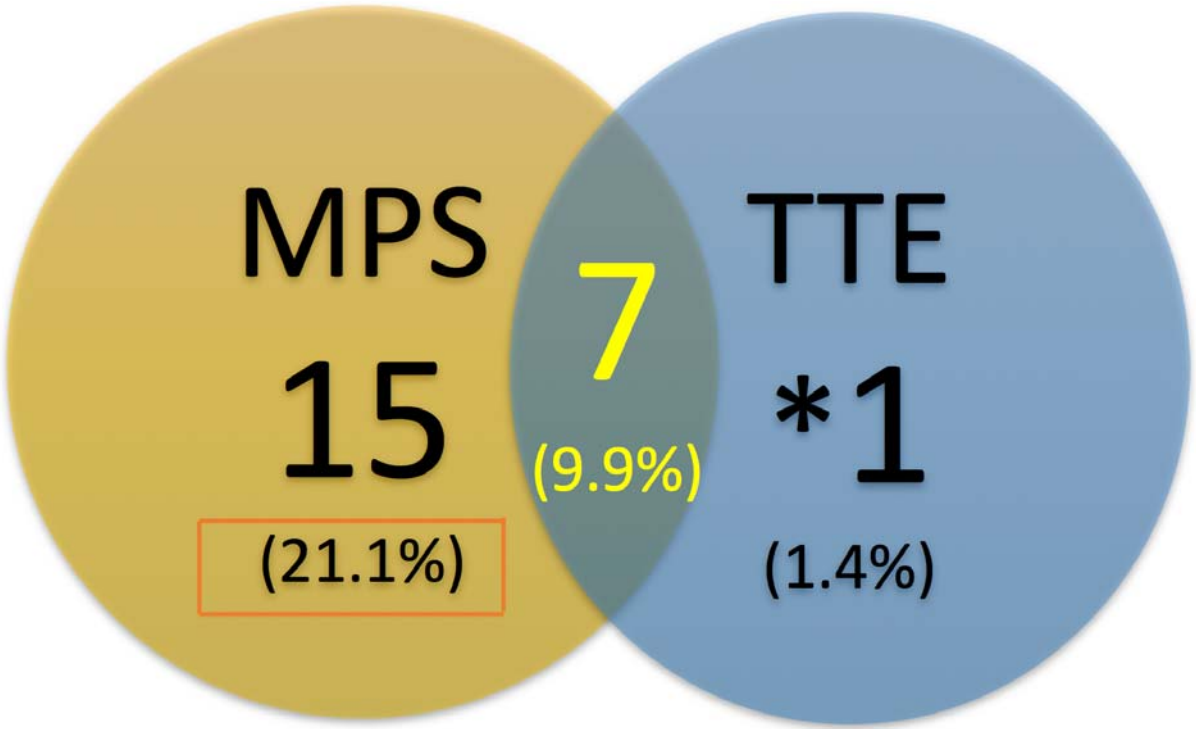
Management

- Varies depending on the nature of the injury diagnosed
  - Myocardial rupture $\rightarrow$ 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

- **<u>MPS impacts patient follow up pathways at RPH.</u>**



- 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