Blunt Mediastinal Trauma
Pump and Tubes

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RADBOUDUMC 2017
Blunt force trauma to the mediastinum
Introduction

No Conflict of Interests
The mediastinum
The different organs in the mediastinum

- Heart
- Aorta and vessels
- Trachea and Bronchi
- Oesophagus
- Thoracic duct
Blunt force sources

- Traffic accidents
- Falls and assaults
- Blast / Explosions
- Work-related accidents
- Crush/ Earthquakes
## Accident Report NTSB/AAR-14/01 PB2014-105984

### 1.2 Injuries to Persons

<table>
<thead>
<tr>
<th></th>
<th>Flight Crew</th>
<th></th>
<th>Flight Crew</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cabin Crew</td>
<td></td>
<td>Passengers</td>
<td></td>
</tr>
<tr>
<td>Fatal</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Serious</td>
<td>1</td>
<td>8</td>
<td>40</td>
<td>49</td>
</tr>
<tr>
<td>Minor</td>
<td>2</td>
<td>2</td>
<td>134</td>
<td>138</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>2</td>
<td>114</td>
<td>117</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>12</td>
<td>291</td>
<td>307</td>
</tr>
</tbody>
</table>

Descent Below Visual Glide path and Impact With Seawall
Asiana Airlines Flight 214 Boeing 777-200ER, HL7742 San Francisco, California July 6, 2013
NTSB/HAR-01/03


Injuries

The following table is based on the International Civil Aviation Organization’s injury criteria, which the National Transportation Safety Board uses in accident reports for all transportation modes.

Table 1. Injuries.

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Driver</th>
<th>Train crew</th>
<th>Bus passengers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Serious</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Minor</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

12 Title 49 Code of Federal Regulations 830.2 defines a fatal injury as any injury that results in death within 30 days of the accident. It defines a serious injury as one that requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; results in a fracture of any bone (except simple fractures of the fingers, toe, or nose); severe lacerations or burns; nerve, muscle, or tendon

...
MVA research

FIGURE T4
THORAX IMPACT TEST SET-UP SPECIFICATIONS

16° NECK ANGLE SETTING

NO. 3 RIB CENTERLINE HORIZONTAL ±0.5°
12° LUMBAR ANGLE (RELATIVE TO LINE PERPENDICULAR TO 18° PELVIC ANGLE OR D-PLANE)

12.7 ±1.0 mm
(0.50 ±0.04 in)

COMPLETE DUMMY ASSEMBLY 420.0000

IMPACT PROBE SUPPORT CABLES
ACCELEROMETER MOUNTED WITH SENSITIVE AXIS IN LINE WITH CENTERLINE OF TEST PROBE LONGITUDINAL AXIS (REF. SA572-T4)
CENTERLINE OF ARMS HORIZONTAL ±2°
TEST PROBE CENTERLINE HORIZONTAL ±0.5°

PELVIC ANGLE MEASUREMENT REFERENCE SURFACE 18° ±1° FROM HORIZONTAL

IMPACT PROBE WEIGHT INCLUDING ALL INSTRUMENTATION AND 1/3 OF SUPPORT CABLE WEIGHT *
6.89 ±0.05 kg (15.2 ± 0.1 lb)

FLAT, SMOOTH, RIGID, CLEAN, DRY SEATING SURFACE HORIZONTAL ± 0.5°

* 1/3 CABLE WEIGHT NOT TO EXCEED 5% OF THE TOTAL IMPACT PROBE WEIGHT
Outcome

Rib fractures,
sternum fracture,
lung contusion,
clavicle fractures
<table>
<thead>
<tr>
<th>Lesión</th>
<th>N</th>
<th>% Quilotórax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roturas diafragmáticas</td>
<td>5</td>
<td>0,3</td>
</tr>
<tr>
<td>Lesión traqueal o bronquial</td>
<td>22</td>
<td>1,2</td>
</tr>
<tr>
<td>Lesión cardíaca o de gran vaso</td>
<td>15</td>
<td>0,9</td>
</tr>
<tr>
<td>Lesión vascular torácica</td>
<td>25</td>
<td>1,4</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>1,7</td>
</tr>
</tbody>
</table>

Outcome
The differences in casualties

- Age,
- Gender
- Weight and size
- Physical fitness, musculature
Age vs. Body Region FRAGILITY (AIS 3+ injury)
(Frontal Crashes, Belted Drivers, 30 mph Crash Severity)
Chest Fragility: Particularly rib fractures

- Aorta (54.1)
- Rib Fx (31.7)
- Hemo-pneumo (11.7)
- Pulm Cont (11.0)
- Hollow Visceral (5.1)
- Liver Lac (6.7)
- Spleen Lac (1.0)
Young Old

Intercostal muscle
Aorta

- Penetrating
- Iatrogenic lesions
- Blunt trauma

Blunt trauma to the thoracic aorta: mechanisms involved, diagnosis and management. Roberto Chiesa\textsuperscript{1}, et all \textit{J Vasc Br} 2003;2(3):197-209
Aorta rupture investigations

- CXR
- CT-A
- TEE
- MRI
- IVUS

Radboudumc
Indications for delaying the aortic repair in the hemodynamically stable patient

• trauma to the central nervous system with coma,
• respiratory failure from lung contusion,
• body surface burns,
• blunt cardiac injury,
• tears of solid organs that will undergo non-operative management,
• retroperitoneal hematoma,
• contaminated wounds,
• age 50 years or older,
• medical comorbidities
Thoracic Aorta repair

• open operative intervention for blunt aortic injury
  • thoracotomy,
  • single-lung ventilation
  • application of an aortic cross-clamp
  • cardiopulmonary bypass may be needed
  • Neuromonitoring included somatosensory and motor-evoked potential monitoring

• Thoracic endovascular aortic repair:
  • TEVAR best outcome survival, spinal cord ischaemia, renal failure, infections

CARDIAC INJURY AND TAMPONADE

- Fatality rates > 80%
- Mostly ventricular, right > left
- Blood in pericardial sac causes tamponade
Blunt cardiac injury with coronary artery dissection

- We report on two cases of young adult presenting with segment elevation myocardial infarction related to CA dissection following rugby game.

doi: 10.4103/0974-2700.155513
Blunt cardiac injury

- AAST Injury Scale for Cardiac Injuries
  - Grade 1: blunt cardiac injury with minor EKG abnormalities
  - Grade 2: with heart block or ischaemic changes
  - Grade 3: With sustained multifocal ventricular contractions, septal rupture, valve disruption, papillary muscle dysfunction, distal coronary occlusion without cardiac failure, blunt pericardial laceration with cardiac herniation, with cardiac failure
  - Grade 4: with septal rupture, valve incompetence, papillary muscle dysfunction with cardiac failure
  - Grade 5: proximal coronary artery occlusion, perforation left ventricular, Stellate injuries with < 50% tissue loss RV
  - Grade 6 Blunt avulsion of the heart; ventricular perforation
Blunt cardiac injury

DIAGNOSIS:
- Ectopy
- ST elevation
- Tachycardia
- Friction rub
- CPK enzymes, Troponin

Monitor in ICU & treat dysrhythmias
- Serial enzymes
- Analgesia
Screening for blunt cardiac injury
EAST practice management guideline

- ECG (level 1), continuous monitoring
- TTE / TEE
- Troponine 1 (level 2)
- Pulmonary artery catheter (Level 3)
- CT scan: only haemopericardium, does not define origin
Trachea and Bronchi

- Blunt force trauma to the tracheobronchial tree: mostly in the distal trachea and right main bronchus
- 1 - 2% blunt chest trauma
- Trachea fixed at the carina
- Shearing forces overcome elasticity of the trachea or bronchus
- Pressure increase against closed glottis
Physical findings trachea/bronchus rupture

- Early death / non-arrival
- Breathing problems, hoarseness
- Cyanosis, hypoxia
- Haemoptysis
- Pain
- Loss of breath sounds
- Subcutaneous emphysema
- Large persistent air leak chest drain
Signs trachea, bronchus disruption

- Subcutaneous emphysema
- Clavicular fracture, rib fractures
- Widened mediastinum
- Pulmonary contusion
- Haemo- pneumothorax
- Fallen lung sign
Fallen lung sign

Fallen lung sign: radiographic findings
Recep Savaş, Hüdaver Alper,
Diagn Interv Radiol 2008; 14:120-121

Emergency Lun-Sparing Surgical Repair of a Complete Transection of the Right Mainstem Bronchus due to lunt Chest Trauma
A. Sachithnandan et al.
Med J Malaysia vol 69 no 2 April 2014
Therapy trachea, bronchus disruption

- Rapid diagnosis
- Rapid DLT intubation
- Bronchoscopy
- Thoracotomy
  - Bronchus repair
  - Pneumonectomy
Blunt oesophageal trauma

- Most due to penetrating trauma

- Oesophageal rupture secondary to blunt chest trauma is 0.001 percent
  - Shearing forces
  - Accidental ingestion sharp/caustic objects

- Of these cases 82% occur above the level of the carina known as the cervico-thoracic esophagus

- 70% rate of delayed presentation; if delayed or missed, rapid sepsis & high mortality
Oesophageal injury

- Difficult to diagnosis
- Radiography
- Endoscopy
- Thoracoscopy
- Treatment: surgical repair via thoracotomy
Oesophagus

Symptoms

• Pain, dyspnoea, fever, crepitus
• Severe mediastinitis
• Emphysema
• Multi-organ failure
• Sepsis
• Chest Drain: turbid fluid, stomach content/food
Oesophagus burns

- First-degree: oedema
- Second degree: ulceration
- Third degree: massive oedema with eschar formation with or without full thickness necrosis
Treatment options

- Conservative
- Primary closure
- Reinforced primary closure
- T-tube drainage
- Exclusion and diversion
- Cave Stomach tube!
Blunt oesophageal trauma
Investigations / therapy

- Barium Swallow
- Oesophagoscopy

Therapy:
- < 24 hrs: surgery, primary repair with muscle flap/ pleural flap
- > 24 hrs: drainage, exclusion and diversion or repair

Intrathoracic esophageal rupture distal to the carina after blunt chest trauma: Case-report
Alex Cedeño, Karla Echeverría, Jan Vázquez, Aura Delgado, Pablo Rodríguez-Ortiz
Barotraumatic Esophageal Perforation by Explosion of a Carbonated Drink Bottle.

Jae Bum Park et al.
The Annals of Thoracic Surgery
Volume 93, Issue 1, January 2012, Pages 315–316
Anatomy Thoracic Duct
Thoracic duct

- **Causes**
  - Neoplastic
  - Traumatic
  - *Usually Penetrating*
  - *Iatrogenic*
  - CVL
  - Oesophagus resection
- **Blunt**
  - Mostly hyperextension of the spine
    Just above diaphragm in the right thorax half
  - Seat belt injury
  - Miscellaneous
  - Congenital
Symptoms:

- Chylos pleural fluid
- Milky
- Mixed with blood
- Yellow, green turbid
- Triglycerid value > 110 mg.dl
- Chylomicrones (Sudan III)
- Lymphangiography

- Late onset symptoms
- Malnutrition
- Chylothorax
Treatment

• Chest tube

• NPO

• Diet

• Nutritional support

• Surgical:
  • VATS
  • Thoracotomy
  • Ligation Thoracic Duct
Differential diagnosis broad mediastinum

• mediastinal widening of more than 8 cm: blood infiltrating normal mediastinal fat,
• downward displacement of the left main stem bronchus,: mass effect of the mediastinal blood
• upward displacement of the right main
• stem bronchus,
obliteration of the contours of the aorta,
• obliteration of the aorto-pulmonary window,
• Displacement of the nasogastric tube or the tracheal tube to the right,
• left apical pleural widening (‘apical capping’): Mediastinal blood migrating to the pleural space will surround the left lung
• haemothorax and fractures of the chest wall
Mediastinum widening

- **Traumatic:**
  - aortic aneurysm, aortic dissection, aortic unfolding, aortic rupture
  - esophageal rupture
  - cardiac tamponade
  - pericardial effusion
  - Thoracic vertebrae fractures

- **Non-Traumatic**
  - hilar lymphadenopathy
  - anthrax inhalation - a widened mediastinum was found in 7 of the first 10 victims infected by anthrax
  - mediastinitis
  - mediastinal mass
Conclusion

• If they arrive alive they stand a good chance
• IF
• Correct interpretation of the forces involved
• High index of suspicion
• Low threshold for investigations