PEDIATRIC TRAUMA: CHEST INJURY

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Chest Injuries In Children

• Usually associated with
  • blunt trauma, less likely penetrating injuries
  • other body system(s) injuries, such as head injury to motor vehicle accident
Differences Between Children & Adults

• Smaller body size
  - Force of trauma dissipated to body more widely, give rise to more severe injuries

• Compliant chest wall - - - > greater elasticity of ribs
  - Allow greater deformity of chest wall before ribs fracture, thus internal injury may occur without any external injury
Differences Between Children & Adults

• Children have a greater cardiopulmonary reserve
  - Compensatory mechanism may mask hypovolemia and respiratory distress
  - Drop in blood pressure is a late sign in children

• The mobility of the mediastinum decreases the risk of major airway and vessel injury.
  - Ventilatory and cardiovascular compromise may occur rapidly, due to the mediastinal shift.
A common response to injury in children is aerophagia, which is often associated with a reflex ileus.

- Can lead to acute gastric dilatation - - - > may further compromise respiratory function
- Need for nasogastric or orogastric tube placement, except orogastric tube for head injury
Primary Survey & Resuscitation

- Resuscitation done simultaneously

- **A**irway with C-spine immobilisation
- **B**reathing : Ventilation & oxygenation
- **C**irculation : Stop bleeding & fluid boluses
- **D**isability : Neurological status
- **E**xposure : Environment & body temperature
Primary Survey & Resuscitation

- It is important to keep potential chest injury in mind when assessing all A, B and C's.

- Preservation of adequate oxygenation of tissue is of paramount importance in early trauma resuscitation. In major thoracic injuries, early intervention may be required for this purpose.
Airway Differences In Children

• Narrower airways
  • more easily obstructed by edema, blood, & foreign bodies
  • most narrower part at the cricoid just below the larynx

• Larger tongue

• Longer floppy epiglottis
  • Because of this, a straight blade laryngoscope is needed for intubation in infants
Airway Differences In Children

• Higher anterior larynx

• Shorter trachea
  • Chest film is required to confirm ETT position

• Larger occiput - - - > neck being flexed when a child is lying supine
Breathing Assessment

Assess for the following :-

• Work of breathing
  ☐ Rate, abnormal breath sounds, signs of respiratory distress

• Adequacy of breathing
  ☐ Chest movement (symmetry & degree in expansion), air entry
  ☐ Infant is diaphragm breathers, do not move chest wall significantly during normal breathing
  ☐ Child with airway obstruction may have chest movement but no air entry
  ☐ SpO2 maintains > 95%, PaCO2 < 40mmHg (4.3kPa)
Breathing Assessment

• Effects of breathing
  - Review mental status, heart rate & skin color

• Complete by examination of chest especially on:
  - Variation in chest expansion & breath sounds
  - Trachea is it centrally placed?
  - Position of apex beat
  - Percussion – is it resonant equally on both sides?
  - Chest or sternal injury
    - Pain
    - Any open wound, flail segment
    - Any bruises, crepitus / surgical emphysema over neck or chest
Circulatory Differences In Children

- Normal vital signs vary with age

- Blood volume is
  - relatively larger (80-90ml/kg) than that of adults (65-70ml/kg)
  - relatively smaller in absolute terms (800mls in a 1-year-old)

- Children compensate for large intravascular losses (>25%) before becoming hypotensive
Circulatory Differences In Children

- Chest-wall is more compliant than in the adult - - - > major contusions or lacerations to the heart and lungs may occur in the absence of rib fractures

- Urine output is relatively greater (Child 1-2mls/kg/hr; Adult 0.5mls/kg/hr)
Effects Of Circulatory Compromise

- Decreased or complete loss of consciousness

- Respiratory distress/failure

- Hypovolemia
  Reduced cardiac output leads to inadequate blood flow to all body organs (Hypovolemic shock)

- Tissue hypoxia, metabolic acidosis and increased respiratory rate

- Ischemic injury to the brain, heart, kidneys, liver, bowel with cell death and inadequate function of these organs
Approach To Chest Trauma

• Hypoxia is the most important presentation in chest injury
  □ Emphasis on proper airway and breathing
  □ Children with chest injury should receive 100% O2 via non-rebreathing mask

• Shock may be the result from blood loss, including intrapleural pressure, vascular disruption, myocardial dysfunction

• Adequate control of pain & breathing
  Chest wall pain will result in frequent shallow respiration - - - - > higher risk of atelectasis and pneumonia
Types Of Chest Injuries

- Lung contusion
- Fracture rib(s)
- Flail chest
- Pneumothorax (simple, tension, or open)
- Hemothorax
- Hemo-pneumothorax
- Tracheo-bronchial injury
- Diaphragmatic injury
- Oesophageal injury
- Cardiac tamponade
- Myocardial contusion
- Injury to aorta
Lung Contusion

- Most common injury and often associated with other injuries, such as fractures
- Hemorrhage and edema is seen inside the lung segment leading to decrease in oxygenation

- Diagnosis
  - Hypoxia
  - Consolidation on CXR and may deteriorate over next 12 to 24 hours

- Treatment
  - Oxygen therapy
  - Analgesia
  - Suctioning
  - Ventilatory support if needed
Rib Fractures

- Compliant chest wall in children can sustain more deformation than the adult chest wall.

- A direct blow to the chest may cause the rib fracture to puncture the lungs, thus should exclude pneumothorax.

- May associate with lung contusion.

- Very painful, causing secondary splinting and hypoventilation.
Rib Fractures

• Treatment
  - Oxygen therapy
  - Analgesia
  - Ventilatory support if necessary
  - Drainage in case of associated pneumothorax
  - Chest physiotherapy
Flail Chest

- It is the result of parallel double fractures of two or more adjacent ribs with subsequent loss of the bony continuity of the thoracic cavity -> paradoxical chest wall movement in the flail segment

- On inspiration, the section collapses whilst the rest of the chest rises; on expiration it bulges whilst the rest of the chest deflates

- Associated respiratory distress from the paradoxical chest wall movement, associated lung contusions and painful rib fractures causing voluntary and involuntary chest splinting
Flail Chest
Flail Chest

Treatment:

• Stabilize the flail segment
  □ Place the child with the injury side down

• Intensive respiratory support
  □ High flow oxygen therapy
  □ Mechanical ventilation if necessary

• Analgesia
Pneumothorax (Simple)

*Presentation*:

- Respiratory distress
- Pleuritic chest pain
- On side of pneumothorax, decreased chest wall movement, decreased breath sounds, may be hyperresonant
- Asymptomatic
Pneumothorax

_Treatment:_

- High flow oxygen therapy
- Analgesia
- Ventilatory support
- If symptomatic or large in size on CXR, will need drainage by intercostal chest catheter
- If asymptomatic and the child is stable, may require intensive monitoring
- If child is being transported or having positive pressure ventilation, a chest drain should be inserted
Tension Pneumothorax

- Life threatening condition
- Shift in mediastinum or trachea to contralateral side
- Hypoxia
- Severe respiratory distress
- Distended neck veins
- Absent or decreased breath sounds
- Hyper-resonance to percussion
- Impaired venous return to heart -> tachycardiac with peripheral vasoconstriction and in hypotensive shock
Tension Pneumothorax

_Treatment_ :-

- High flow oxygen therapy
- Urgent needle thoracocentesis
- Followed by intercostal drain insertion
Pneumothorax (Open)

• Secondary to penetrating wound
• Air may be in and out of the wound with breathing

• Treatment
  - High flow oxygen therapy
  - Analgesia
  - Occlude wound with dressing (3 sides only to allow air to escape during expiration)
  - Chest drain insertion
Hemothorax

- Presentation :-
  - Respiratory distress
  - Decreased chest movement
  - Decreased air entry
  - Dullness on percussion

- Treatment :-
  - High flow oxygen therapy and ventilatory support if necessary
  - Establish IV access for fluid resuscitation
  - Insertion of chest drain
  - Consult surgeon for ongoing hemothorax or failure to stabilize circulation with resuscitation
Hemo-pneumothorax

- A combination of the accumulation of both blood and air in pleural space

- Presentation and treatment same as hemothorax
Tracheo-bronchial Injury

• Rare and potential life threatening
• Results from trauma to region between larynx and segmental bronchus

• Diagnosis
  - Pneumothorax or hemopneumothorax
  - Partial airway obstruction
  - Subcutaneous emphysema
  - Continuous air leak, despite chest drain is inserted
Tracheo-bronchial Injury

• Treatment
  - High flow oxygen therapy
  - Analgesia
  - ETT insertion beyond tear
  - Ventilation
  - Adequate oxygenation in large tears may be difficult to obtain
  - Referral to thoracic surgeon for definitive care
Traumatic Asphyxia (‘Run Over’ Injury)

• Caused by prolonged severe compression of the chest as in crushing injuries, resulting in obstruction of the venous return - - > leaks to extravasation of blood into tissues and massive - - > lack of circulation and oxygen

• Diagnosis
  - Petechiae of upper chest, neck, arms and face
  - Bulging eyes
  - Subconjunctival hemorrhage
  - Underlying vascular injury
    - Assess pulses, bruits, hematomas, neurologic deficits
  - Underlying nerve injury
    - Observe motor and sensory deficits
Traumatic Asphyxia (‘Run Over’ Injury)

• Treatment
  - High flow oxygen therapy
  - Intubation and ventilatory support
  - Analgesia
  - Spinal immobilization
  - Treatment must be directed at underlying injuries
  - Refer to thoracic surgeon for definite care
Diaphragm Injury

- Results from forceful blunt trauma causing a major rise in intra-abdominal pressure
- Tear is usually on the left
- Can result in the displacement of abdominal viscera into the chest with associated respiratory compromise

- Treatment
  - High flow oxygen therapy
  - Analgesia
  - Surgical referral
Esophageal Injury

- Usually results from a penetrating injury rather than blunt injury
- An exception is the severe blow to the upper abdomen, which may result in the forcible ejection of stomach contents into the esophagus, resulting in a linear tear in the lower esophagus

- Treatment
  - Antibiotic cover for mediastinitis
  - Pleural drainage and repair
  - Major tears may require esophageal diversion
Cardiac Tamponade

• Blunt or penetrating injury to the chest may cause bleeding into the pericardium

• May come from a cardiac chamber, a great vein or artery, or from the myocardium in the presence of myocardial contusion $\rightarrow$ decreased filling of the heart, reduced stroke volume and shock
Cardiac Tamponade

• Presentation
  - Shock / hypotension
  - A narrow pulse pressure
  - Distended neck veins
  - Soft heart sounds
  - Raised CVP
  - Unexplained refractory shock

• Investigation
  Diagnosis confirmed by ultrasound examination if time is available
Cardiac Tamponade

- **Treatment**
  - Ongoing ABC
  - Monitor ECG
  - Needle pericardiocentesis if there is severe shock and poor surgical support
  - Open surgical drainage / placement of drain by specialist is safer and more reliable
Myocardial Contusion

• Blunt direct injury to the sternum may also injure the myocardium, resulting in an area of contusion, bleeding within heart muscle, bruising and damage or infarction of muscle fibers, particularly the anterior wall of the heart

• Presentation
  - May not cause any clinical effect in most cases
  - Some children may be complicated by low cardiac output due to impaired cardiac function, arrhythmias, pericarditis, and hemopericardium with possible tamponade
  - Older patients may complain of pre-cordial pain
Myocardial Contusion

- **Investigations**
  - ECG to detect changes similar to those of myocardial infarction and arrhythmias
  - Cardiac isoenzymes, such as CKMB, Troponin I
  - Echocardiogram to detect evidence of impaired myocardial dysfunction

- **Treatment**
  - Supportive
  - Cardiac monitoring in PICU
  - Follow-up isoenzymes and echocardiogram
Traumatic Rupture Of Aorta

• Rare injury in children or adolescents, more common in adults

• Results from rapid deceleration injury, typically from high speed motor car or motor bike accidents

• In many cases, immediate massive bleeding into the left pleural cavity and result in death

• Treatment
  Repair of the aorta or graft repair
Conclusion

• Chest injury in children is seldom in isolation, usually in association with other injuries

• Chest injury in children may occur in the absence of external wound

• Treatment is usually guided by oxygenation and the underlying cause of injury

• Tetanus vaccination