Thoracic trauma [created by Paul Young; 27/10/07]

general

- thoracic trauma is reponsible for 20% of all trauma-related deaths & is 2nd only to head trauma as a primary cause of death at injury scenes
- although many thoracic injuries are not immediately life threatening they have the potential for significant morbidity & mortality

initial assessment

General:
- ATLS provides the basic tenets for management of all injured patients.
- Initial treatment involves:
(i) primary survey
(ii) resuscitation
(iii) secondary survey
(iv) diagnostic evaluation
(v) definitive care

Airway:
- although the most typical threats to airway control are neurological injury, facial trauma & foreign body obstruction, trauma to the larynx, trachea or bronchus may complicate or preclude airway control

Breathing:
- thoracic trauma commonly causes life-threatening breathing problems including:
(i) pneumothorax
(ii) haemothorax
(iii) pulmonary contusion
(iv) flail chest

Circulation:
- thoracic trauma may also cause life-threatening circulation problems including:
(i) tension pneumothorax
(ii) cardiac tamponade
(iii) great vessel injury

pneumothorax

General:
- pneumothorax is a common sequela of thoracic trauma
- visceral pleural disruption due to penetrating trauma, blunt shearing or lacerations from fractured bones, allows air to enter the pleural space as negative intrapleural pressure is created during inspiration

Physical findings:
- include decreased breath sounds, hyperresonance to percussion & decreased expansion of the chest wall on the affected side

Tension pneumothorax
- mediastinal structures are shifted away from the affected side & venous return to the heart is impaired due to vena caval distortion

Open pneumothorax:
- results from a full thickness chest wall wound
- may be immediately managed by an occlusive dressing secured on three sides, to prevent sucking of more air but allowing egress of the pneumothorax until definitive wound closure and tube thoracostomy can be performed

'Occult pneumothorax'
- with the growing use of CT scanning in the evaluation of trauma patients, small pneumothoraced are often discovered
- treatment of these 'occult' pneumothoraces is not as well defined as for the usual pneumothorax & observation may be appropriate even in the setting of positive pressure ventilation

haemothorax

General:
- can range from small & assymptomatic to massive & immediately life threatening
- a small haemothorax can be difficult to appreciate on a chest radiograph [in the upright position blunting of the costophrenic angle requires 200-250ml of blood whilein the supine position, there may only be a subtle haziness on the affected side]

Massive haemothorax:
- a massive haemothorax is usually the result of a major vascular injury & is life threatening.

Treatment:
- Immediate return of 1500ml of blood or continuing loss of 250ml/hr for 3hrs is an indication for thoracotomy
- haemothoraces with blunt chest wall trauma can pose special challenges & in particular cases one might consider arteriographic embolisation of intercostal bleeders
- one should be suspicious of an initial high volume loss which suddenly ceases & repeat chest radiography should be performed to exclude blockage of the ICC

chest wall injury

rib fractures:
- are estimated to occur in 10% of patients presenting for evaluation by a trauma service & are usually (90%) associated with other injuries
- multiple rib fractures, fractures of the 1st and 2nd rib and scapular fractures signify high-energy injuries
- single rib fractures in young patients are generally of little consequence; however, rib fractures in elderly patients can lead to diminished pulmonary function & disasterous infectious complications
- patients over 65 have a 2-5 fold increase morbidity & mortality compared to younger patients with similar injuries and in the eldery Bulger et al found that each additional rib fracture increases mortality by 19% and pneumonia by 27%
- pain control is the key factor in management of these injuries with evidence demonstrating that epidurals are superior to PCAs for this indication; intercostal blocks are another alternative

flail chest
- two or more ribs fractured in two or more places produces a flail segment of the chest wall which moves paradoxically
- mechanical effects on respiration are related to the size of the flail segment; however, underlying pulmonary contusion rather than mechanical effect of the flail is usually the major cause of respiratory compromise
- treatment is supportive with endotracheal intubation and positive pressure ventilation sometimes required
- surgical stabilisation of the flail segment is not routinely performed but may be consided in particular circumstances [overall its benefits are marginal]

sternal fracture:
- early series of sternal fractures described the 'steering wheel syndrome' as the most common cause of sternal fracture. In these series, associated blunt cardiac injury was common and thus sternal fractures were thought to be harbingers of significant occult thoracic injury
- recent series of sternal fractures occuring in the context of 'selt belt syndrome' have determined that associated injuries are rare in this context

tracheobronchial injury

- uncommon but should be excluded in the presence of cervical subcutaneous empysema, pneumomediastinum,or pneumothorax with a persistent air leak
- although CT may reveal some injuries, the preferred diagnostic test is bronchoscopy
- laryngotracheal injuries often require tracheostomy as an adjunct to repair whereas tracheal and bronchial injuries may be repaired without tracheostomy
- positive end-expiratory pressure should be minimised post-operatively where possible

esophageal injury

- blunt force mechanisms may cause a sudden rise in intraluminal pressure or the upper oesophagus may be crushed between the trachea and a vertebral body; however, oesphageal injury is usually the result of penetrating trauma
- pneumomediastinum should raise the suspicion of this injury
- options for investigation include oesophagoscopy or, if the patient is awake, barium swallow
- if injury is identified within 24 hours it can be primarily repaired; otherwise drainage & delayed repair is employed

respiratory support of the chest injured patient

- Conservative
- Non-invasive respiratory assistance (via face mask)
  - Continuous positive-airways pressure (CPAP)
  - Pressure support ventilation (PSV)
  - Bi-level positive airway pressure (BiPAP)
- Invasive respiratory assistance (via a tracheal tube)
  - CPAP
  - PSV ± positive end-expiratory pressure (PEEP)
  - intermittent mandatory ventilation ± PEEP ± PSV
  - pressure control ventilation ± PEEP
  - volume control ventilation ± PEEP
  - high frequency ventilation (major air leaks)
  - independent lung ventilation ± PEEP
- Surgical stabilization ± other measures

great vessel injury

Penetrating injuries:
- patients with penetrating injuries to extrapericardial thoracic great vessels usually succumb in the field;
- approach to surgical treatment of patients with penetrating injuries to great vessels can be inferred from the location of wounds and the chest radiograph

Blunt injuries
- blunt thoracic great vessel injuries require tremendous force because the aortic arch branch arteries are protected by strong musculoskeletal tissues
- the most common site of injury is the aortic isthmus (just distal to the left subclavian at the location of the ligamentum arteriosum) followed by the innominate artery
- experience with intravascular stenting is growing but is still relatively limited
- In the American Association of Trauma multicentre study, widening of the mediastinum was present in 85% of cases; however, 7% of patients with a torn aorta had a normal chest x-ray
- Helical CT scan is now well accepted as a screening test and in a large series had a sensitivity of 100% when haematoma adjacent to the thoracic aorta was considered a positive test.
- once aortic injury is diagnosed, SBP and HR should be rapidly controlled to reduce shear stress using a rapidly reversible beta blocking agent
- paralysis is a significant risk associated with aortic repair due to cross clamp and spinal artery occlusion

pericardial tamponade

- should be suspected in all patients sustaining penetrating injuries to the anterior chest wall
- acute tamponade of as little as 100ml of blood within the pericardial sac can produce life threatening haemodynamic compromise
- compensatory mechanisms can transiently stabilise the haemodynamic status and fluid resuscitation may improve the vital signs; however, a high index of suspicion and early diagnosis are key.
- bedside echocardiography is extremely helpful
- if pericardial tamponade is present patient should be immediately transported to the operating theatre; if there is a delay a pericardiocentesis or subxiphoid pericardial window should be performed
- pericardiocentesis is successful in decompressing 80% of cases with most failures due to clotted blood in the pericardium; if pericardiocentesis is unsuccessful and the patient remains hypotensive with SBP<70 then ED thoracotomy should be performed

penetrating cardiac injury

- cardiac penetration is rapidly lethal in 90% of gunshoot wounds and up to 50% of stab wounds
- the most important factor for survival is rapid transport to a trauma centre, early diagnosis and immediate treatment; patients arriving in extremis after penetrating chest trauma should undergo ED thoracotomy
- gun shot wounds generally bleed freely into the chest while stab wounds are more commonly associated with tamponade

blunt cardiac injury

General:
- blunt cardiac injury ranges from assymptomatic patients with minor enzyme rises to patients with fulminant cardiac failure
- occurs most commonly in motor vehicle accidents but can occur following virtually any trauma to the chest

Chest injury	Chest related death	Odds ratio
Three fractured ribs unilateral	17.3%	1.01
Three fractured ribs bilaterally	40.9%	3.43
Lung contusion unilateral	25.2%	1.82
Contusion bilateral and haemothorax	53.5%	5.1

Cardiac Rupture:
- 80-90% are lethal within minutes
- may result from direct impact force to the heart or pressure transmitted via venous channels; deceleration with lacerations at junctions between fixed & mobile structures (eg atriocaval disruptions); myocardial contusion,with subsequent necrosis and rupture; broken ribs or sternum penetrating the heart
- patients who reach the hosptial alive typically have a pericardial effusion and may develop pericardial tamponade

Pericardial injury:
- may result from direct thoracic impact or from an acute increase in intra-abdominal pressure
- tears most commonly occur on the left parralleling the phrenic nerve (64%)
- herniation of the heart through a large tear may be associated with significant cardiac dysfunction

Valvular injury:
- lethal cardiac trauma involves the valves in approximately 5% of patients
- the most commonly injured valve is the aortic followed by the mitral, tricuspid & pulmonary
- aortic cusps may be lacerated or avulsed when a sudden increase in intrathoracic pressure leads to a concomitant rise in aortic pressure
- violent compression of the heart in early systole may tear mitral leaflets but more commonly leads to papillary muscle rupture
- aortic and mitral valve injuries often lead to acute heart failure

Septal injury:
- septal injuries are found in 5-7& of patients dying from blunt trauma
- ventricular septal ruptures are more common than atrial ones and may manifest as a loud holosystolic murmur or AV conduction abnormalities

Coronary artery injury:
- direct injuries to the coronary arteries are rare but lead to important sequelae of dissection & thrombosis
- LAD is the most susceptable (76%) followed by right coronary (12%)
- cardiac catheterisation is the investigation of choice and angioplasty may be performed
- coronary artery laceration may result in pericardial tamponade and myocardial ischaemia; the decision as to whether to ligate or reconstruct vessels can be complex & depends on anatomy and associated injuries

lung injury

pulmonary contusion:
- a common problem in severely injured multitrauma patients
- may result from a direct blow, shearing or bursting at an interface or transmission of a shock wave
- pathophysiologic changes fundamentally involves haemorrhage with surrounding oedema & manifests clinically with hypoxia, hypercarbia & increased work of breathing due to V/Q mismatch & decreased pulmonary compliance
- may not appear radiographically on initial presentation but are usually seen by 6 hours post injury & are seen more readily on CT chest in the early stages
- the degree of pulmonary dysfunction usually peaks at 72 hours and generally resolves within 7 days in the absence of nosocomial pneumonia
- an admission PF ratio of <250 predicts a poor outcome
- post-traumatic pulmonary pseudocysts are cavitatory lesions that occur in 3% if parenchymal lung injuries; they generally cause few symptoms & resolve in 2-4 months

pulmonary laceration:
- pulmonary laceration may be caused by penetrating trauma, blunt shearing or the endsof fractured bones
- the typical clinical presention is of haemopneumothorax
- bleeding is usually self limiting and a chest tube is the only required treatment
- of the 10% requiring thoracotomy, approximately 20% need a lung resection