Anaesthetic management of blunt chest trauma

Introduction:

Trauma anaesthesiology is a unique subspecialty of our profession. Anesthesiologists are involved in the care of trauma patients beginning with airway and resuscitation management in the casualty room and proceeding through the operating room to the intensive care unit. The thorax is one of the most commonly injured structures resulting from trauma. The chest wall, lung parenchyma, trachea, oesophagus and vascular structures may be involved, individually or in combination. Severe chest injuries are responsible for 25% of all trauma deaths, and in a further 25% they are a contributing cause of mortality.

Life-threatening injuries involving the thoracic cage can be classified according their severity into 2 categories

1. Immediately life threatening - which ought to be identified during the primary survey and
2. Potentially life threatening – which has to be detected during the secondary survey.

Immediately life threatening injuries
- Airway obstruction
- Tension pneumothorax
- Pericardial tamponade
- Open pneumothorax
- Massive hemothorax
- Flail chest

Potentially life threatening injuries
- Thoracic aortic disruption
- Trachea-bronchial injuries
- Blunt myocardial injuries
- Diaphragmatic injuries
- Oesophageal injuries
- Pulmonary contusion
Thoracic traumas can also be classified according to the nature of injuries into
1. Non-penetrating injuries - blunt trauma, deceleration or blast forces.
2. Penetrating injuries - gunshots, stabs, arrows and high velocity splinters.

The most common presentation of thoracic trauma is associated rib fractures, and approximately 85% of them can be treated without specialised surgical intervention. Tube thoracostomy, adequate analgesia, supplemental oxygen and aggressive respiratory therapy often suffice. Those patients requiring immediate surgery are often haemodynamically unstable, have persistent bleeding, tracheal or oesophageal injury. Chest X-rays are of paramount importance and should be obtained as early as possible. Associated injuries such as pneumothorax, haemothorax or pulmonary contusion must be excluded. Injuries to the chest wall and thoracic viscera can directly impair oxygen transport mechanisms. The hypoxia and hypoxaemia that results may cause secondary injury, especially to the brain. Brain injury can secondarily aggravate thoracic injuries by disrupting normal ventilatory patterns. In addition, the lung is a target organ for secondary injury following shock and remote injury.

Principles of management of thoracic trauma:
1. assessment and resuscitation
2. physical examination
3. diagnostic studies
4. life-saving surgery

The management of the thoracic trauma victim starts right from the site of occurrence and the victim should be transported immediately to a trauma center. Most life-threatening thoracic injuries can be simply and promptly treated after identification, by needle or tube placement for drainage. Resuscitation has two components – the primary survey with initial resuscitation followed by secondary survey if patient improves.

Primary survey: is aimed to
A. Establish airway and ventilation.
B. Maintain circulation in terms of cardiac function and intravascular volume.
C. Check neurological status (GCS)
D. Determine the mechanism of injury.

Secondary Survey: for diagnostic studies and surgical priorities should be followed once the patient becomes haemodynamically stable after initial resuscitation.

INJURY SEVERITY SCORE (ISS) & NEW INJURY SEVERITY SCORE (NISS)

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Acute Injury Score (AIS) and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score. As multiple injuries within the same body region are only assigned a single score, a proposed modification of the ISS, the "New Injury Severity Score" (NISS), has been proposed. This is calculated as the sum of the squares of the top three scores regardless of body region. The NISS has been found to statistically outperform the traditional ISS score.

MANAGEMENT OF IMMEDIATE LIFE THREATENING THORACIC INJURIES:

1. Airway obstruction
   The most common cause in the unconscious patient is obstruction caused by the tongue. Dentures, teeth, secretions and blood can contribute to airway obstruction in trauma. Early intubation is very important, particularly in cases of neck haematomas or possible airway oedema.

2. Tension pneumothorax
   A tension pneumothorax develops when a ‘one-way-valve’ air leak occurs, either from the lung or through the chest wall. Air is forced into the thoracic cavity, completely collapsing the affected lung. The mediastinum gets displaced to the opposite side, decreasing venous return and compressing the opposite lung. The most common causes are penetrating chest trauma, blunt chest trauma with
parenchymal lung injury that did not spontaneously close, iatrogenic lung punctures and mechanical positive pressure ventilation.

Tension pneumothorax is a clinical diagnosis and treatment should not be delayed by waiting for radiological confirmation. Treatment consists of immediate decompression and is managed initially by rapidly inserting a large bore needle into the second intercostal space in the midclavicular line of the affected hemithorax. This is immediately followed with a chest tube insertion.

3. Pericardial tamponade

   All patients with penetrating injury anywhere near the heart plus shock must be considered to have cardiac injury until proven otherwise. Pericardial tamponade is most commonly the result of penetrating trauma and needs to be differentiated from tension pneumothorax in the shocked patient with distended neck veins. The classic diagnostic Beck’s triad consists of venous pressure elevation, decline in arterial pressure and muffled heart sounds. Pulsus paradoxus and Kussmaul’s sign could further suggest pericardial tamponade. High index of suspicion and further diagnostic investigations (chest X-ray, showing enlarged heart shadow or cardiac echo showing fluid in the pericardial sac) are required for the subclinical case. In cases where major bleeding from other sites has taken place, the neck veins may be flat. The correct immediate treatment of tamponade is operative (sternotomy or left thoracotomy) with repair of the heart.

4. Open pneumothorax

   This is due to a large open defect in the chest (> 3 cm), leading to equilibration between intrathoracic and atmospheric pressure. Air accumulates in the hemithorax with each inspiration, leading to profound hypoventilation and hypoxia. Signs and symptoms are usually proportionate to the size of the defect. Initial management consists of promptly closing the defect with a sterile occlusive dressing taped on three sides to act as a flutter-type valve. If the patient is not intubated a chest tube is inserted as soon as possible in a site remote to the injury site.

5. Massive haemothorax

   Accumulation of blood in a hemithorax can significantly compromise respiratory efforts by compressing the lung and preventing adequate ventilation.
Such massive accumulation of blood presents as haemorrhagic shock, unilateral absence of breath sounds, dullness to percussion, and flat neck veins. The treatment consists of correcting the hypovolaemic shock, insertion of an intercostal drain, and in some cases intubation. Blood in the pleural space should be removed as completely and rapidly as possible in order to prevent ongoing bleeding, empyema or late fibrothorax. Clamping a chest drain to tamponade a massive haemothorax is usually not helpful. Initial drainage of more than 1,500 ml of blood or ongoing haemorrhage of more than 200 ml/h over 3 - 4 hours is generally considered indications for urgent thoracotomy.

6. Flail chest

A flail chest occurs when a segment of the chest wall does not have bony continuity with the rest of the thoracic cage. This condition usually results from blunt trauma associated with multiple rib fractures, i.e. two or more ribs fractured in two or more places. The blunt force required to disrupt the integrity of the thoracic cage typically produces an underlying pulmonary contusion. The diagnosis is clinical, not radiographic. The chest wall must be observed for paradoxical motion of a chest wall segment for several respiratory cycles and during coughing. Voluntary splinting due to pain, mechanically impaired chest wall movement and the associated lung contusion cause hypoxia. The patient is also at high risk for immediate or delayed pneumothorax or haemothorax. Traditional treatment consisted of mechanical ventilation to ‘internally splint’ the chest until fibrous union of the broken ribs occurred. The price for that was considerable in terms of ICU resources and ventilation-dependent morbidity. Currently the treatment consists of oxygen administration, adequate analgesia and physiotherapy. Ventilation is reserved for patients developing respiratory failure. Operation is another treatment option for flail chest, after having been discarded in the past due to the view that underlying pulmonary contusion was the dominant pathology. Now a selected group with isolated, severe chest injury and flail segments has been shown to benefit from internal operative fixation.

MANAGEMENT OF POTENTIAL LIFE THREATENING THORACIC INJURIES:

1. Thoracic aortic disruption
Traumatic aortic rupture is a common cause of sudden death after an automobile collision or fall from a great height. For the subgroup of immediate survivors salvage is frequently possible if aortic rupture is identified and treated early. It should be clinically suspected in patients with a discrepancy of the blood pressure between left and right arm or between upper and lower limbs, a widened pulse pressure and chest wall contusion. Erect chest X-ray can also suggest thoracic aortic disruption, the most common radiological finding being a widened mediastinum. The diagnosis is confirmed by aortography, or contrast spiral CT scan of the mediastinum and to a lesser extent by trans-oesophageal echocardiography. The treatment is immediate open operative intervention. In selective cases conservative management consisting of control of the systolic arterial blood pressure (~ 100 mg Hg) and postponement of the operation is advisable in patients who are physiologically unstable due to trauma in other anatomical areas.

2. Tracheobronchial injuries

Severe subcutaneous emphysema with respiratory compromise can suggest tracheobronchial disruption. The chest drain placed on the affected side will reveal a large air leak, and the collapsed lung may fail to re-expand. Bronchoscopy is diagnostic. Treatment involves intubation of the unaffected bronchus followed by operative repair.

3. Blunt myocardial injury

Significant blunt cardiac injury that causes haemodynamic instability is rare. Blunt myocardial injury should be suspected in any patient with significant blunt trauma who develops ECG abnormalities in the resuscitation room. Diagnostic tools are 12-lead ECG tracings and two-dimensional echocardiography that can show wall motion abnormalities. All patients with myocardial contusion diagnosed by conduction abnormalities are at risk for sudden dysrhythmias and should be monitored for the first 24 hours. After this interval the risk for sudden dysrhythmias decreases substantially, unless significant stress like a general anaesthetic is added.

4. Diaphragmatic injuries

A high index of suspicion is needed in stab wounds below the nipple line as in normal expiration the diaphragm rises up to the fifth intercostal space. Diagnosis of
blunt diaphragmatic rupture is missed even more often in the acute phase due to associated injuries. There is no single gold standard of investigation. Chest radiography after placement of a nasogastric tube, contrast studies of upper or lower gastrointestinal tract, CT scan, and diagnostic peritoneal lavage have an only limited positive or negative predictive value. Most accurate evaluation is by video-assisted thoracoscopy or laparoscopy, the latter offering the advantage of easier repair and additional evaluation of the abdominal organs. Operative repair is recommended in all cases.

5. Oesophageal injury

Most injuries result from penetrating trauma; blunt injury is rare. A high index of suspicion is required. The patient can present with odynophagia, subcutaneous or mediastinal emphysema, pleural effusion, retro-oesophageal air, and unexplained fever within 24 hours of injury. The mortality rises exponentially if treatment is delayed more than 12 - 24 hours. Mediastinal and deep cervical emphysema must be seen as evidence of an aero-digestive injury until proven otherwise. Combination of oesophagogram in decubitus position and oesophagoscopy confirm the diagnosis in the great majority of cases. The treatment is operative.

6. Pulmonary contusion

Pulmonary contusion is caused by haemorrhage into the lung parenchyma, usually underneath a flail segment or fractured ribs. This is a very common potentially lethal chest injury and the major cause of hypoxaemia after blunt trauma. It is an independent risk factor for pneumonia and adult respiratory distress syndrome (ARDS). The natural progression of pulmonary contusion manifests as worsening hypoxaemia for the first 24 - 48 hours. The chest X-ray findings are typically delayed and non-segmental. Contrast CT scan can be confirmatory. If abnormalities are seen on the admission chest X-ray, the pulmonary contusion is severe. Haemoptysis or blood in the endotracheal tube is a sign of pulmonary contusion. In mild contusion the treatment is oxygen administration, aggressive pulmonary toilet and adequate analgesia. In more severe cases mechanical ventilation is necessary. While one should avoid fluid-overloading these patients to counteract a trend to pulmonary oedema, establishment of normovolaemia is critical for adequate tissue perfusion and fluid restriction is not advised.
Pain Management of Blunt Thoracic Trauma

Epidural analgesia is the optimal modality of pain relief for blunt chest wall injury and is the preferred technique after severe blunt thoracic trauma. Patients with 4 or more rib fractures should be provided with epidural analgesia unless this treatment is contraindicated. High-risk patients who are not candidates for epidural analgesia should be considered for paravertebral (extrapleural) analgesia.

Intravenous narcotics, by divided doses or demand modalities may be used as initial management for lower risk patients presenting with stable and adequate pulmonary performance as long as the desired clinical response is achieved.

General anaesthetic management considerations:

1. Pre-operative assessment:
   Inclusion of anaesthesiologist in trauma team saves valuable time from resuscitation to pre-operative evaluation. In a conscious patient, a brief history could be taken, with emphasis on NPO status.

2. Induction:
   Any intravenous anesthetic administered to a trauma patient in hemorrhagic shock may potentiate profound hypotension and even cardiac arrest as a result of inhibition of circulating catecholamines. Although propofol and sodium thiopental are the mainstays of intravenous induction, both drugs are vasodilators and both have a negative inotropic effect. Ketamine continues to be popular for induction of anesthesia in trauma patients; however, it is also a direct myocardial depressant. Etomidate is a good alternative because of its cardiovascular stability, although its inhibition of catecholamine release may still produce profound hypotension.

3. Intubation:
   A trauma patient is always considered to have a full stomach and to be at risk for aspiration during induction of anesthesia. Anesthesia and neuromuscular blockade allow the best intubating conditions on the first approach to the patient's airway, which is advantageous in an uncooperative, hypoxic, or aspirating patient. Attempts to secure the airway in an awake or lightly sedated patient increase the risk
for airway trauma, pain, aspiration, hypertension, laryngospasm, and combative behavior. Endotracheal intubation is best accomplished in almost all cases with a modified rapid-sequence approach by an operator with experience in this practice. Cricoid pressure should be applied continuously, from the time that the patient loses protective airway reflexes until endotracheal tube placement and cuff inflation is confirmed. All blunt trauma victims be assumed to have an unstable cervical spine and the presence of an “uncleared” cervical spine mandates the use of in-line manual stabilization throughout any attempt at intubation. Succinylcholine remains the popular neuromuscular blocker for rapid-sequence induction, with fastest onset—less than 1 minute—and shortest duration of action—5 to 10 minutes. Rocuronium, 0.9 to 1.2 mg/kg, would be the best alternative, as the profound block could be immediately reversed by sugammadex. Emergency awake fiberoptic intubation, though requiring less manipulation of the neck, is generally very difficult because of airway secretions and hemorrhage. Indirect video laryngoscopy with Bullard laryngoscope or GlideScope would need more clinical experience.

4. Maintenance:

Hypotension will develop in hypovolemic patients with the administration of any anesthetic because of interruption of compensatory sympathetic outflow and the sudden change to positive-pressure ventilation. O₂/air mixtures, muscle relaxants, narcotics, amnestic and minimal inhalational agents can be used. The use of nitrous oxide should generally be avoided as it has a propensity to increase the size of gas filled cavities including air emboli and pneumothorax. Monitoring should include invasive arterial blood pressure measurement as well as placement of a central venous catheter. Non-responding fluid replacement therapy from upper veins may indicate towards possibility of tear in SVC. In such condition cannulate lower extremity veins and vice versa. Awareness is a major but almost unavoidable hazard. Scopolamine and midazolam will reduce the incidence of patient awareness but can also contribute to hypotension.

5. Post-operative care:

A significant number of these patients will need critical care, including mechanical ventilation, after the initial resuscitative phase and/or post-surgical intervention. Chest injury, shock, emergency intubation and blood transfusion are all risk factors
for development of later ventilator associated pneumonia and sepsis. Other strategies such as Nitric Oxide, Prone positioning, High frequency oscillatory ventilation, Extra-corporeal membrane oxygenation, Extra-corporeal carbon dioxide removal, Partial liquid ventilation, Recombinant factor VIIa may be needed in the appropriate scenarios for better outcome.

Conclusion:

Successful peri-operative care of these trauma victims require a good understanding of the basics, supplemented by preparation, flexibility and ability to react quickly to the changing circumstances. Community based prevention include efforts to incorporate air bags in all motor vehicles, mandate helmet use on motor cycles, encourage citizens to wear seat belts and punish intoxicated drivers.

References: