EMERGENT MANAGEMENT OF CHEST INJURIES

Onakpoya U.U[1], Omotoso O.A[2], Orifowomo T.D[3]

[1] *Consultant, Cardio-thoracic Surgeon, Department of Surgery, Obafemi Awolowo University and Obafemi Awolowo University Teaching Hospitals, Ile-Ife*
[2] *Clinical III, Faculty of Clinical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile-Ife*
[3] *Clinical I, Faculty of Clinical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile-Ife*

ABSTRACT

Chest injuries being either due to blunt and, or penetrating trauma, can cause death during the first minutes or hours after trauma and often are associated with bleeding with injuries interfering with respiration, circulation and, or both. Penetrating trauma is always surgically treated and the foreign body is removed in the operating room (OR). Life-threatening conditions, such as tension pneumothorax have to be treated by thorax drainage prior to hospital admission. Patients requiring emergency thoracotomy are either in shock or have life threatening injuries and, as expected, have significant mortality and morbidity. Patients may present with a simple dyspnea or even respiratory arrest. Adequate pain control in chest trauma is sometimes the most basic and best treatment and with a definite diagnosis, the morbidity and mortality can be significantly reduced by simple treatment methods and after the Primary and Secondary survey, constant reevaluation of the patient ensures that new findings are not overlooked.

INTRODUCTION

Chest trauma is a common cause of morbidity and mortality and is the third most common cause of death after abdominal and head trauma in poly traumatized patients [1, 2]. The differences in the severity and complexity of these injuries constitute a challenging issue for clinicians worldwide. Therefore, advanced health care methods are needed to reduce morbidity and mortality rates.

There is a great need for an effective strategy to manage patients with chest injuries rapidly.

This is because when compared to other traumatic injuries, chest trauma, characterized by life-threatening conditions explained primarily by the complexity of thoracic lesions and related respiratory failure, and secondarily by consequences of hypoxemia and inflammatory reaction on other organ functions [3] . The overall mortality rate for thoracic trauma is 15–25%, even higher in cardiac or tracheobronchial-esophageal injuries. The presence of thoracic injuries in poly-trauma settings can significantly increase the mortality rate because they can be complicated by lung contusion, flail chest, pneumothorax, and haemothorax [4].

Of the 720,000 annual traumatic patients' admissions in the United Kingdom, over 17,000 traumatic deaths occur, with nearly 25% of them directly due to thoracic injuries [5]. Motor vehicle collisions cause Two-thirds of blunt thoracic trauma or more in developed countries, the other one-third being caused by blows from blunt objects or falls from height [4, 6].

Chest trauma may emanate from penetrating trauma produced by knife stabs, gunshots, arrows, and spears or due to blunt trauma, including blast injuries, motor vehicle accidents, and iatrogenic injuries secondary to both therapeutic interventions and diagnostic procedures as injury to the lungs and heart during catheterization [7] .

CAUSES AND CLINICAL FEATURES

Chest injuries usually occur in car crashes, falls from heights, sports injuries, and violent acts.

The most affected compartments include the chest wall, pleura, and lungs. Rare but often very severe are the trauma of the airways (2.8 to 5.4 %), diaphragm (0.4–1.5 %), large vessels (1.1 to 2.2 %), and heart (10 %) [8, 9].

According to the underlying cause, the injuries are classified as blunt (90 %) and penetrating (10 %) injuries. Blunt injury is caused by three primary mechanisms, which are often combined. These are a direct impact, compression, and deceleration [8]. Direct impact on the chest causes a localized injury of the chest wall at the point of contact. When exposed to significant forces, the energy can affect the deeper structures located in their trajectories, such as lungs, heart, blood vessels, mediastinum, liver, or spleen. The compression causes pressing of the organs against the spine or chest wall and their contusion or rupture. The pulmonary parenchyma, pleura, diaphragm, and tracheobronchial tree are often affected. Deceleration causes movement of the organs and shearing forces at the site where they are fixated; this generates trauma of the tracheobronchial tree, aorta, heart, and diaphragm.

The causes of a penetrating trauma often are stab and gunshot wounds in victims of violence and war. With a higher incidence of vascular and heart injuries, a penetrating trauma has higher mortality compared to a blunt trauma [10].

In most cases, blunt chest trauma leads to fractures of the bony thorax, i.e., ribs. In the case of accompanying haemothorax or pneumothorax, initial management consists of chest tube drainage [11], especially in life-threatening conditions, such as tension pneumothorax, while injury to the great vessels or heart requires care in specialized centres.

In the United States of America, thoracic trauma causes about a quarter of traumatic deaths.
Many chest injuries cause death during the first minutes or hours after trauma and often are associated with bleeding. Most morbidity and mortality due to chest trauma occurs because injuries interfere with respiration, circulation, or both. Injuries frequently are treated at the bedside with definitive or temporizing measures that do not require advanced surgical training.
Therefore, patients with general thoracic trauma must be urgently, accurately, and reliably evaluated in emergency units, and the source of bleeding identified [12].
Some of the significant chest injuries include the following:

- Aortic disruption
- Blunt cardiac injury
- Cardiac tamponade
- Flail chest
- Hemothorax
- Pneumothorax (traumatic pneumothorax, open pneu mothorax, and tension pneumothorax)
- Pulmonary contusion
- Bone injuries are common, typically involving the ribs and clavicle. Fractures of the sternum and scapula may occur but not as commonplace.

Respiration can be compromised by:

- Direct damage to the lungs or airways
- Altered mechanics of breathing

Injuries that damage the lung or airways directly include pulmonary contusion and tracheobronchial disruption, which on occasions can be severe. Injuries that alter the mechanics of breathing include haemothorax, pneumothorax, and flail chest. Injury to the lung, tracheobronchial tree, or rarely esophagus may allow air to enter the soft tissues of the chest and/or neck (subcutaneous emphysema) or mediastinum (pneumomediastinum) [13]. This air inside is not the origin of the problem; instead, the underlying injury is. Tension pneumothorax impairs respiration as well as circulation [13].
Circulation can be impaired by; bleeding, decreased venous return, direct cardiac injury.
Bleeding, for example, in haemothorax can be massive, resulting in shock, and in some instances, can also impair breathing. Decreased venous return impairs cardiac filling, leading to hypotension, and can result from increased intrathoracic pressure in tension pneumothorax or increased intrapericardial pressure as seen in cardiac tamponade.

Heart failure and conduction abnormalities can result from a blunt cardiac injury that damages the myocardium or the heart valves [13] .
Symptoms include pain worsening on breathing if the chest wall is injured, tachypnea, respiratory distress, tachycardia, hypotension, tracheal deviation away from the side of the injury, unilateral absence of breath sounds, elevated hemithorax without respiratory movement, neck vein distention, cyanosis (late manifestation)
Neck vein distention can occur in tension pneumothorax or cardiac tamponade if patients have sufficient intravascular volume. Decreased breath sounds can as well result from pneumothorax or hemothorax; and as regards percussion notes produce dull with haemothorax and hyperresonant with pneumothorax. The trachea can deviate away from the side of a tension pneumothorax.
In flail chest, a segment of the chest wall moves paradoxically—that is, in the opposite direction from the rest of the chest wall (outward during expiration and inward during inspiration); the flail segment is often palpable.
Subcutaneous emphysema causes a crackling or crunch when palpated, and findings may involve a small area or large portion of the chest wall, extend to the neck, or both.

Most often, pneumothorax is the cause. Which when extensive, injury to the tracheobronchial tree or upper airway should be appropriately ruled out. Air in the mediastinum may produce a characteristic crunching sound synchronous with the heartbeat (Hamman sign or Hamman crunch). Hamman sign suggests pneumomediastinum and often tracheobronchial tree injury and, in rare cases, oesophagal injury.

ADVANCED TRAUMA LIFE SUPPORT [ATLS] IN RELATION TO CHEST TRAUMA

Most patients who sustain thoracic trauma can be treated by technical procedures within the capabilities of clinicians trained in ATLS. Initial assessment and treatment of patients with thoracic trauma consist of the primary survey with the resuscitation of vital functions, detailed secondary survey, and definitive care. Hypox-

ia being the most severe consequence of chest injury, the early intervention aims to prevent or correct hypoxia, or both. Injuries that are an immediate threat to life are treated as quickly and simply as possible. Most life-threatening thoracic injuries can be treated with airway control or decompression of the chest with a needle or tube.
The history of the injury and a high index of suspicion for specific injuries influences the secondary survey.

PRIMARY SURVEY: IDENTIFYING LIFE-THREATENING INJURIES

The primary survey encompasses the ABCDE of trauma care and identifies life-threatening conditions by adhering to this sequence [14] :

- Airway maintenance with restriction of cervical spine motion
- Breathing and ventilation
- Circulation with haemorrhage control
- Disability (assessment of neurologic status)
- Exposure/Environmental control

Physiologic parameters such as pulse rate, blood pressure, pulse pressure, ventilatory rate,
arterial blood gases, body temperature, and urinary output are assessable measures that reflect
the adequacy of resuscitation. Values for these parameters should be obtained as soon as is
practical during or after completing the primary survey and reevaluated periodically. Major
problems should be corrected as they are identified. Some conditions are immediately life-threatening, and not a few are rapidly correctable at the bedside at the time of diagnosis [14,19].
These include:
· Massive haemothorax- Tube thoracostomy can be instituted to relieve the respiratory
distress and assess for the volume of bleeding
Tension pneumothorax- Needle decompression can help alleviate this emergency until a closed
thoracostomy tube drainage can be instituted

· Open pneumothorax- Partially occlusive dressing followed by tube thoracostomy
· Flail chest- Intercostal nerve blocks and generous analgesics nay suffice at the early stages, while severe cares with massive lung contusion will require mechanical ventilation
· Cardiac tamponade- Traumatic cardiac tamponade due to a penetrating chest injury is frequently managed by expeditious sternotomy or anterior thoracotomy to arrest the cardiovascular injury.
Massive hemothorax results from the rapid accumulation of more than 1500 mL of blood or one-third or more of the patient's blood volume in the chest cavity [14] . Massive haemothorax should be excluded in all patients who have shock after major trauma, especially in blunt chest trauma where a haemothorax may not be evident on cursory inspection of the patient.

SECONDARY SURVEY

The secondary survey begins soon after the primary survey is completed, resuscitative efforts are underway, and improved patient's vital functions have been demonstrated. The secondary survey of patients with thoracic trauma involves further in-depth physical examination, ongoing ECG and pulse oximetry monitoring, arterial blood gas (ABG) measurements, upright chest x-ray in patients without suspected spinal column instability, and chest computed tomography (CT) scan in selected patients with suspected aortic or spinal injury [14] .

Some of the potentially lethal injuries which are identified and managed during the secondary survey include [14, 19] :

- Pulmonary contusion
- Blunt cardiac injury
- Traumatic aortic disruption
- Traumatic diaphragmatic injury
- Blunt oesophagal rupture

Anterior and posterior visual evaluation of the chest can help identify conditions such as open pneumothorax and large flail segments. Examination includes inspection, palpation, auscultation, and percussion of the chest, and a chest x-ray. After the Primary and Secondary survey, constant reevaluation of the patient ensures that new
findings are not overlooked and helps discover any deterioration in previously noted findings.
Continuous monitoring of vital signs, oxygen saturation, and urinary output is essential.

FURTHER INVESTIGATIONS AND MANAGEMENT

Diagnostic imaging plays a vital role in deciding on the therapeutic procedure and determining the eventual outcome. Clinical symptoms of chest injuries are diverse with varying severity and present in various forms. As such, diagnostic investigation is of extreme importance. The choice of a diagnostic procedure depends on the patient's condition and the mechanism of the trauma.

For example, Ultrasonography in the emergency room is a reliable method to exclude pleural and pericardial effusions. In low-energy trauma (falls from heights of up to 3m and traffic accidents at speeds of up to 50 km/hr), the standard method includes X-ray and ultrasound
examinations [17] to exclude conditions that require imme-

diate intervention. The sensitivity of a chest X-ray in the emergency room based on some studies carried out over a period of time was found to be 58.3% [18] .
For those with high-energy trauma (falls from heights above 3m and traffic accidents at speeds exceeding 50 km/h) and patients with unknown mechanisms of trauma, the chest multidetector computed tomography [MDCT] examination should be performed as a screening method [17] . This can also be used in cases of unclear findings or if specific details are required to make an assessment.
Multidetector computed tomography is considered a very effective imaging method in this field and should be an integral part of the emergency department [15, 16]. MDCT enables sufficiently accurate assessment of all chest compartments and reveals changes that are not detectable by other methods [17] . Additional findings are prevalent in MDCT (up to 83% of cases), but only some of them can change the therapeutic process (7–41 %) [17]. It allows performing two-dimensional (2D) and three-dimensional (3D) reformations in any plane and angle of view without loss of geometric resolution and to evaluate the anatomical structures

When should the thoracic surgeon be involved in the management?

According to the ATLS guideline, this is recommended as follows [19]:

- Blood loss over the closed thoracostomy tube drain of >1,500 mL initially or >200 mL/hour over 3 consecutive hours;
- Hemoptysis;
- Massive subcutaneous emphysema;
- Persistent air leak
- Uncertain images on the chest X-ray or CT thorax;
- Penetrating chest trauma.

Indications for an immediate thoracic surgical intervention are [19] :

- Blood loss ≥1,500 mL initially/>200 mL/hour over 2–4 hours;
- Endobronchial blood loss; massive contusion with significant impairment of mechanical ventilation;
- Tracheobronchial tree injury (air-leakage/hemothorax);
- Injury of the heart or large vessels (blood loss/pericardial tamponade).

VIDEO-ASSISTED THORACOSCOPIC SURGERY (VATS)

Video-assisted thoracoscopic surgery (VATS) management in chest-trauma patients is not as common, and studies carried out on its effectiveness are few. However, its ongoing acceptance and use in major thoracic resection has helped improve elective surgery patients' management [20]. VATS is also a useful explorative and therapeutic tool for managing diaphragmatic lesions. In some cases, VATS is considered to be related to lower acute respiratory distress syndrome rates in comparison to open thoracotomy patients [21] .

In the haemodynamically stable patients with small penetrating wounds, VATS can be a valuable weapon of thoracic surgeons for fast recovery, minimized pain, and perfect visualization of the entire pleural space [17]. Indications for such an approach include penetrating injuries with little blood loss in a stable patient, persistent haemothorax, empyema, persistent air leak, and suspicion of diaphragmatic rupture [17].

TUBE THORACOSTOMY

A tube thoracostomy is performed on patients for the treatment of traumatic pneumothorax and/or haemothorax. It is an essential surgical intervention in situations requiring drainage of the pleural cavity in patients who have had chest trauma. In these patients, the tube is inserted in the triangle of safety with access gained into the 4th or 5th intercostal space for pneumothorax and haemothorax respectively. In cases with no apparent pneumothorax and/or haemothorax, a tube thoracostomy could still be performed in the intensive care unit in severe chest trauma requiring mechanical ventilation [22] . With the presence of a penetrating or blunt chest trauma patient with vitals completely lost, or about to be lost, it would not be erroneous to perform an emergency bilateral tube thoracostomy [23, 24] .

After the tube thoracostomy is complete, the position of the chest tube and the status of the air or fluid in the pleural space should be evaluated through direct lung radiography. The chest tube should never be clamped for any reason. At the same time, the patient is being moved or transferred outside the emergency unit, and the tube thoracostomy is removed only after the air leak stops, drainage drops below 100 mL/day, or after chest radiographic confirmation of adequate lung reexpansion [25] .

CONCLUSION

Patients with thoracic trauma should be evaluated quickly. Life-saving interventions should
be implemented by the emergency physician, ambulance physician and, or both in the event of
primary life-threatening injuries. Imaging methods are an integral part of the diagnostic algorithm
in chest injuries and should be used appropriately.

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