

Modern Management of Traumatic Hemothorax

Hamid Reza Mahoozi, Jan Volmerig and Erich Hecker*

Thoraxzentrum Ruhrgebiet, Department of Thoracic Surgery, Evangelisches Krankenhaus, Herne, Germany

*Corresponding author: Erich Hecker, Thoraxzentrum Ruhrgebiet, Department of Thoracic Surgery, Evangelisches Krankenhaus, Herne, Germany, Tel: 0232349892212; Fax: 0232349892229; E-mail: e.hecker@evk-herne.de

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Abstract

Hemothorax is defined as a bleeding into pleural cavity. Hemothorax is a frequent manifestation of blunt chest trauma. Some authors suggested a hematocrit value more than 50% for differentiation of a hemothorax from a sanguineous pleural effusion. Hemothorax is also often associated with penetrating chest injury or chest wall blunt chest wall trauma with skeletal injury. Much less common, it may be related to pleural diseases, induced iatrogenic or develop spontaneously. In the vast majority of blunt and penetrating trauma cases, hemothoraces can be managed by relatively simple means in the course of care.

Keywords: Traumatic hemothorax; Internal chest wall; Cardiac injury; Clinical manifestation; Blunt chest-wall injuries; Blunt intrathoracic injuries; Penetrating thoracic trauma

Introduction

Hemothorax is one of the most frequent consequences of thoracic traumas. Early detection and treatment of hemothorax is of utmost importance in prognosis of the patient. About 60% of polytraumas are associated with thoracic trauma. 150,000 Americans die due to trauma every year and it is the most common cause of death in the population <40 years age. One fourth of deaths are particularly related to chest trauma.

Mortality associated with a great vessel or cardiac injury is significant, with >50% of patients dying immediately and less than 10-15% surviving until hospital admittance with critical vital signs.

Etiology

The etiology of hemothorax is commonly subdivided into traumatic and non-traumatic. The traumatic hemothorax is a result of blunt or penetrating trauma. Non traumatic hemothorax may develop by various diseases or disorders such as neoplasia, lung sequester, ruptured pleural adhesion in the case of pneumothorax, pulmonary infarction, tuberculosis, pulmonary infection (e.g. Dengue hemorrhagic fever), pulmonary arteriovenous fistulae and abdominal anomaly and pathology [1-7].

Pathophysiology

Intrapleural or extrapleural injuries can lead to a hemothorax. The physiologic response to a hemothorax contains an early and a late response. The early response is manifested in two major aspects: hemodynamic and respiratory. The late response is manifested in two forms: empyema and fibrothorax.

The severity of pathophysiological response is dependent on location of injury, the functional reserve of patient and amount of blood loss.

Hemodynamic response

As above mentioned the hemodynamic response is a multifactorial response and depends on severity of hemothorax according to its classification. Hemothorax is classified according to the amount of blood loss: minimal, moderate, or massive.

A minimal hemothorax is defined as a blood loss without significant hemodynamic changes. Blood loss in a 75-kg patient without underlying disease up to 750 ml is usually without any significant hemodynamic response and classified as minimal hemothorax. The hemodynamic response is adjusted usually to amount of blood loss, underlying disease and location of injury.

If the patient has pre-existing pleural bonding, the adhesions may limit the amount of blood loss, particularly from low-pressure sources and may be lifesaving.

Blood loss of more than 30% of blood volume (1500-2000 ml) is usually associated with hemorrhagic shock (massive hemothorax) [8,9].

Respiratory response

Numerous factors affect the respiratory response. A trauma associated respiratory failure may occur directly or indirectly. An indirectly associated respiratory failure occurs because of pulmonary infection, fibrothorax as a late complication and trauma in a patient with underlying disease.

A directly trauma associated failure occurs as a result of direct pulmonary, chest wall and cardiac injury or systemic response in form of ARDS resulting from diffuse alveolar damage with increasing capillary permeability [9,10].

Physiologic resolution of hemothorax

Defibrination of hemothorax commences some hours after formation of hemothorax. Some degree in defibrination of hemothorax concludes incomplete clotting. After lysis of hemothorax by the pleural enzymes increases the concentration of protein. An intrapleural hyperosmotic pressure produces a positive osmotic gradient and promotes formation of a pleural effusion. By this, relatively small

amounts of blood in the pleural space may have a similar effect to that of chronic subdural hematomas, drawing in fluids over time and causing a large effusion with little actual blood content [1,9,11].

Late physiologic systemic reaction

Late physiologic reactions of hemothorax consist of empyema and fibrothorax.

Primary or secondary contamination of hemothorax concludes empyema. Bronchio-tracheal lesions, esophageal injuries, diaphragmatic and subdiaphragmatic injuries, accumulation of fluid in the subdiaphragmatic area and postsurgical contamination contribute to development of posttraumatic empyema (Figure 1).

Fibrothorax results from fibrin deposition in the pleural surfaces [12]. An undrained pleural fluid regardless of its origin induces an inflammatory response and leads to inflammatory coating of visceral and parietal pleura. The chest wall and diaphragm are affected in a similar process, which in total leads to entrapment of the lung. The entrapment of the lung restricts the ventilatory function and typically reduces lung volume [12].

Clinical Manifestations

Clinical manifestations of patients with chest trauma are dependent on mechanism of injury and the organs involved. Patients who suffer blunt thoracic trauma are at considerable risk of associated injuries, deterioration and mortality [13]. In contrast to penetrating thoracic trauma, the biomechanical force required to produce significant blunt thoracic injury often results in multiple injuries including abdominal, head and extremity injuries [14].



Figure 1: Chest X-ray; left-sided hemothorax after blunt trauma.

Blunt chest wall injuries

Blunt chest wall traumas may cause hemothorax, pulmonary contusion, pulmonary laceration, traumatic pulmonary pseudocyst, pulmonary hematoma, traumatic asphyxia and bony skeletal injuries. Multiple rib fractures are the most common blunt chest injuries and occur in about 36-50% of cases (about 36% on the right side, and 51% on the left side).

A small hemothorax may be overlooked during physical examination and even chest radiography.

The chest wall injuries are subdivided to simple and complex chest wall injuries.

A simple chest wall injury consists of less than three single rib fractures and superficial soft tissue injuries. This type of injury usually can be handled by conservative treatment.

Fractures of three or more sequential ribs and a flail chest are categorized as complex chest wall injuries and frequently associated with a significant degree of hemothorax.

A hemothorax can develop after some interval of trauma. Possible mechanisms of development of delayed hemothorax are displacement of fractured ribs with pulmonary parenchymal laceration, lesion of the diaphragm or intercostal vessel disruption [15,16].

Blunt intrathoracic injuries

Vascular injuries usually lead to large hemothoraces. Laceration of great vessels and heart injuries may result in hemorrhage into the pleural space and subsequent exsanguination. In rare conditions, partial tears of vessels create hematomas that may help to arrest the hemorrhage.

Symptoms vary widely from mild to severe, depending on pattern and location of injury. Respiratory manifestations related to large hemothorax as well as dullness to percussion and absent breath sounds are noted as typical signs and symptoms [6,14,16].

Penetrating trauma

The most common reason for hemothorax after penetration is direct laceration of arteries of the chest. Other intrathoracic structures, including heart and pulmonary parenchymal injury should be considered (Figure 2).

Pulmonary parenchymal injury in penetration of the chest wall is very common and usually self-limiting, but these injuries usually result in a hemo-pneumothorax [10,16].

Clinical manifestation in traumatic hemothorax

In case of trauma, thorough and accurate physical examination should be exercised. Bloody pleural effusion distributes in supine position and can be easily missed during the physical examination. It is strongly advised to perform physical examination in upright position or a slight reverse Trendelenburg position of the patient in order to identify smaller hemothoraces. Less than 500 ml bloody pleural effusion in the costophrenic angle may be overlooked in physical examination (Figure 3).

The origin of hemothorax may arise from an intra-abdominal injury. The possibility of intra-abdominal injury e.g. of spleen, liver, stomach and vessels should be considered in every case of hemothorax and particularly in case of encountered diaphragmatic injury [8,16].

Treatment

The treatment of hemothorax contains an early phase e.g. hemorrhagic shock, respiratory compromise or retained clot and a late phase e.g. fibrothorax and empyema.

Minimal collection of blood (defined as <300 ml) in the pleural cavity requires no treatment; the blood is usually resorbed over several weeks. If the patient is stable and presents with minimal respiratory distress, operative intervention is not required. This group of patients can be treated by analgesia as needed and observed with repeated chest radiographs at 4-6 hours and 24 hours [17]. In case of pulmonary parenchymal fistulae after insertion of thoracostomy tube a possibility of thoracoscopic approach should be evaluated and considered.

According to the Advanced Trauma Life Support (ATLS) guidelines, 1500 ml of blood drainage in 24 hours or >250 ml of blood drainage hourly for three consecutive hours after chest tube insertion are the criteria for surgical exploration after penetrating chest trauma. These criteria, however, are not mandatory. Other accepted indications for surgical exploration are management and prevention of the late complications such as fibrothorax and empyema [6,18-20]. If emergent thoracotomy is indicated adequate exposure of the entire pleural cavity is required.

Closed tube thoracostomy

Needle aspiration as a definitive treatment of a hemothorax is an obsolete intervention. The adequate approach to a hemothorax is a complete evacuation of retained clots either by tube thoracotomy or videoassisted thoracoscopy (VATS) [6,8,17-19].

Adequate management of hemothorax mandates complete evacuation of the blood collection. A 24- or 28-french chest tube is commonly sufficient to accomplish this goal.

Incomplete or ineffective drainage particularly in the case of severe pleural adhesions is contraindicated. In such cases, VATS or thoracotomy with dissection of adhesions is a safer approach [8,17-20].

Drainage in patients with coagulopathy

Drainage of hemothorax in case of coagulopathy should be performed carefully with consideration of the underlying disease. Correction of coagulation function prior to surgical intervention should be performed if permitted by clinical patient status. Needle aspiration in case of untreated coagulopathy is contraindicated [6,18].

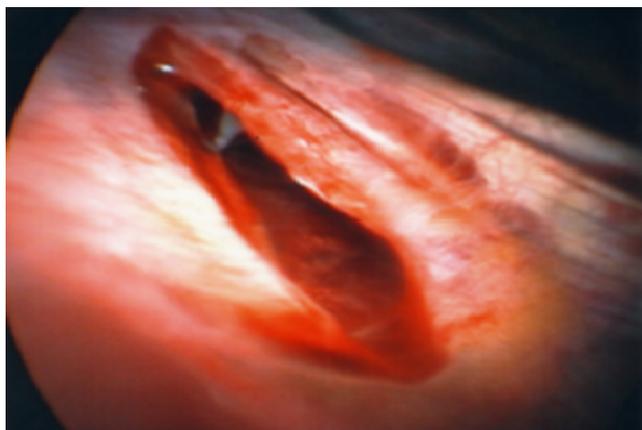


Figure 2: Hemothorax in penetrating trauma.

Video-Assisted Thoracoscopy (VATS)

Video-assisted thoracoscopy (VATS) provides entire vision of the complete pleural cavity with the possibility to correct chest tube – placement, control of bleeding and removal of retained clot [20,21]. Most authors advise a VATS in the case of hemothorax with more than 300 ml because of more favorable outcomes compared to patients who did not receive a VATS [20-22].

Thoracotomy

The procedure of choice in critical situation with massive hemothorax and suspicion of injury of heart and great vessels is thoracotomy. When urgent thoracotomy is required in emergency, the choice of incision is influenced by many factors including operative indications, mechanism of injury and the radiographic findings.

The indications for urgent thoracotomy as outlined by the ATLS protocol:

- Chest drainage >1500 ml initial or >200 ml/hr
- Large unevacuated clotted hemothorax
- Developing cardiac tamponade
- Chest wall defect
- Massive air leak or incomplete lung expansion despite adequate drainage
- Great vessel injury
- Esophageal injury
- Diaphragmatic injury
- Cardiac injury (traumatic septal or valvular injury)

Intubation in urgent situations should be commenced rapidly to prevent aspiration. Thoracotomy is sometimes required in the case of empyema stage III according to ATS (American Thoracic Society) classification.



Figure 3: Left-sided hemothorax and atelectasis of left lower lobe.

Management of retained clot

Management of retained clot comprises controversy opinions from conservative therapy to surgical approach. Frequent current opinion advocates an early thoracoscopic approach (VATS) and removal of

retained clot with mobilization of the lung for re-expansion. Early video-assisted thoracoscopy (VATS) has greatly diminished the late complication of hemothorax with positive impact on the length of stay in the hospital and survival of patients particularly in elderly. Published studies revealed clinical outcomes in patients who received early VATS were more favorable compared to patients who did not receive early VATS [6,18-23].

Video-assisted thoracoscopic surgery (VATS) is believed to be the best available modality for the management of clotted hemothorax. However, VATS is not routinely available in many centres. One easily available and effective alternative to VATS is the use of intrapleural fibrinolysis (IPF) [24-31]. There have not been any prospective trials to

answer this question but in a retrospective analysis, VATS was found to be superior to IPFT, both in terms of decreased hospital stay and necessity thoracotomy (Figure 4).

Complications

Inadequate or incorrect placement of chest tubes leads to insufficient hemothorax drainage. Bacterial contamination of long-term retained clot in tube thoracostomy or undrained hemothorax can promote empyema [26]. Fibrothorax develops as a late complication due to inflammatory coating of visceral and parietal pleura and reduces the ventilatory function. Decortication of visceral pleura is the therapy of choice to provide lung reexpansion [15,24,25].

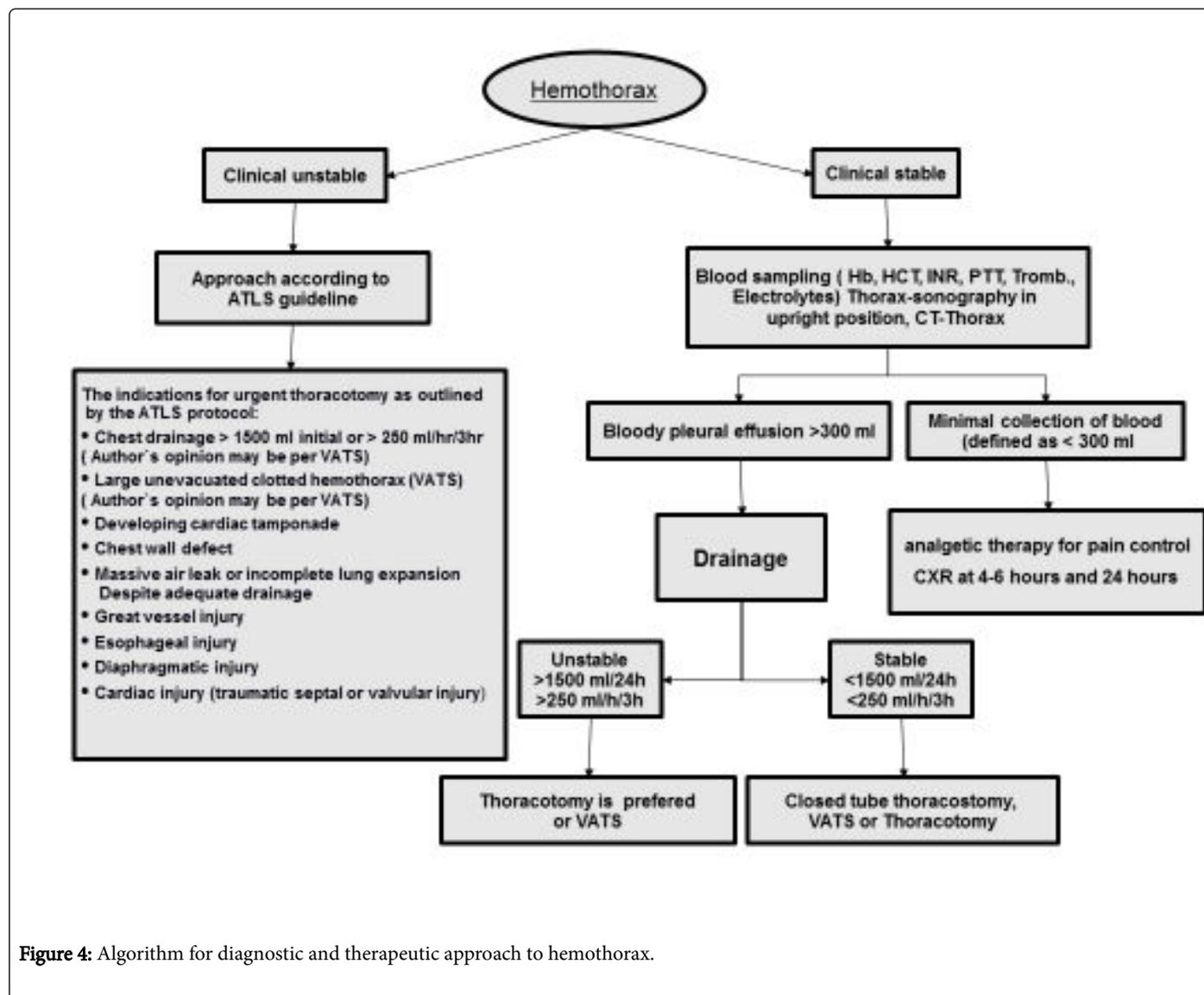


Figure 4: Algorithm for diagnostic and therapeutic approach to hemothorax.

Outlook and Discussion

The decision for early removal of retained hemothorax/ blood clots per VATS greatly reduces late complications such as empyema, fibrothorax, morbidity and necessity of late secondary thoracotomy. In addition, early VATS approach reduces the length of hospital stay compared to sole tube thoracostomy or conservative management of

hemothorax. Abdominal sonography in case of chest trauma should be performed routinely [6,15,18-21].

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