Hemothorax: Diagnosis and Management

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Abbreviations

VATS = video-assisted thoracic surgery

Hemothorax is the presence of blood in the pleural space. Its clinical significance is related to the absolute volume of blood, its rate of accumulation, etiology, and chronicity. When bloody fluid is found during thoracentesis of a pleural effusion, it may represent frank hemorrhage or simply a bloody effusion from a malignancy or inflammation. If there is doubt about the diagnosis, a hematocrit on the fluid may be obtained; a hemothorax ought to be considered present only if the fluid hematocrit is >50%.1

Causes of Hemothorax

Trauma is the most common cause of hemothorax.2 Surgical consultation must be obtained immediately in the process of stabilization and evaluation of patients with traumatic hemothoraces.

Blunt chest trauma may result in rib fractures, diaphragmatic and pulmonary laceration, great vessel injury, and cardiac rupture with tamponade. Penetrating chest trauma may result in intercostal laceration, great vessel and cardiac perforation, and injury to the diaphragm, spleen, liver, kidneys, and hollow viscus organs.

Rib fractures bleed most commonly from torn intercostal vessels but may instead cause laceration of the lung or diaphragm. Intercostal arteries, though small, bleed persistently and can result in significant blood loss into the pleural space. Laceration of arterial vessels in the muscular diaphragm, from displaced lower rib fractures, can bleed like intercostal arteries. Pulmonary lacerations, unless of hilar vessels, are low pressure sources and generally cease with tube thoracostomy, evacuation, and reexpansion of the lung. All of these injuries require chest-tube drainage and close monitoring of blood loss to determine the need for surgical repair of the bleeding source.

Patients with bleeding from great vessel injuries, including the pulmonary hilum, usually present in extremis with a massive hemothorax and require immediate surgical repair to sustain life. Mortality from these injuries is very high.

The clinician should have a high index of suspicion for underlying associated injuries in the patient with traumatic hemothorax. Pulmonary and cardiac contusions accompany significant blunt chest trauma. Subclavian and great vessel injuries may accompany fractures of the upper ribs and scapula; injury to this part of the thoracic skeleton implies great force, and fractures may be the least dangerous component of...
injury in these patients. Diaphragmatic hernia may masquerade as a pleural effusion, as cases of inadvertent intubation of herniated organs attest. Diaphragmatic injury with bleeding from the spleen or liver may result in hemothorax.

Iatrogenic hemothorax may result from perforation of venous structures during central venous catheter placement, laceration of intercostal vessels during thoracentesis, complications of needle biopsies, and chest wall or lung injury during tube thoracostomy. Postoperative bleeding and hemothorax after thoracic and cardiac procedures are familiar complications and yield best to early surgical intervention. Chest-tube drainage of >500 mL in the 1st h after chest surgery, or >250 mL/h for several hours, suggests the need for reexploration if coagulation parameters have been corrected.

Spontaneous hemothorax occurs in the settings of intrapleural malignancy or spontaneous pneumothoraces with torn vascularized adhesions and in patients with coagulation abnormalities. These are managed with chest-tube drainage, correction of any coagulopathy, and occasional surgical evacuation and repair of the bleeding source.

Management of Hemothorax

The presence of a hemothorax is often strongly suggested by a history of trauma or instrumentation, associated with symptoms and physical findings. Symptoms and signs in trauma patients relate directly to the acute injury and may include hypotension, tachycardia, dyspnea, and chest pain. In nontraumatic situations, the major symptom is dyspnea. Physical findings are characteristic of a pleural effusion, including diminished breath sounds on the involved side associated with dullness to percussion. Palpation of the chest wall may reveal tender rib fractures or soft tissue swelling. The trachea may be deviated when large volumes of blood are present, which causes mediastinal shift to the contralateral side.

Chest radiographs reveal a pleural effusion, which may be not entirely free flowing because of partial clotting of the hemothorax. Associated chest wall fractures may be present. Anemia may be found, depending on the chronicity of the hemothorax. In trauma situations the immediate hematocrit level may not fall until intravascular volume has been restored with crystalloid infusions.

Prompt surgical consultation is paramount in the appropriate and timely management of patients with hemothorax. Chest-tube drainage is essential management. It drains the pleural space, allows reexpansion of the lung, and permits assessment of ongoing hemorrhage. The rate of persistent hemorrhage and the overall state of the patient dictate further management.

Chest tubes for traumatic hemothoraces ought to be placed in the midaxillary line (in line with the anterior superior iliac crest) at or just below the level of the inframammary or infrapeITORAL crease. This results in placement anterior to the latissimus dorsi via the 6th intercostal space or so, which is dependent enough to adequately drain any pleural fluid, high enough to minimize the incidence of inadvertent diaphragmatic injury, and anterior to significant chest wall musculature. Patients with chest trauma usually splint the injured side, which causes the diaphragm to rise; because the diaphragm inserts at the 9th rib laterally, intubation via the 6th interspace is safe in most cases. Tube insertion can be done in the supine position during trauma resuscitation, but in stable patients it is most easily done in the lateral decubitus position with the arms forward. The tube ought to be of adequate caliber to evacuate a large volume of blood quickly and remain patent (28F to 32F). Larger tubes are unnecessary and difficult for
the occasional practitioner to insert, and smaller tubes tend to clot off. A common mistake is to insert the chest tube too far into the pleural space. This results in kinking of the tube, perforation of the visceral pleura, or entrapment of the drain holes in a lung fissure. As long as the most proximal sidehole of the tube is within the pleural space, air and fluid will drain adequately.

Chest-tube placement via the anterior 2nd intercostal space is not appropriate for hemothoraces: these drain poorly, must be placed through the pectoral muscles, tend to kink at the insertion site afterward, and are in the way of other resuscitation activity. The anterior chest wall ought not to be the initial tube thoracostomy site for any intrapleural process except for the emergency management of pneumothorax.

All chest drains must be attached to a water-seal collection device; suction at –20 cm H₂O is usually applied in an effort to augment drainage, but the mechanics of the pleural space evacuate pleural fluid very well with water seal alone via a properly placed chest tube. The chest tube should be clamped in four situations only: (1) disconnection of the tube from the collection device, (2) changing a full or malfunctioning collection device, (3) during removal of the chest tube, and (4) if sudden hypotension follows rapid evacuation of a large hemothorax.

One exception to prompt chest-tube insertion is when clinical and radiologic signs suggest a dissection or transection of the aorta. Intercostal drainage in this situation can lead to rapid exsanguination. If suspected, the diagnosis must be excluded before chest-tube drainage.

On insertion of the chest tube, rapid evacuation of 1 to 2 L of blood is not unusual and may be disconcerting. The immediate volume drained is less important than the rate of ongoing loss after initial drainage. Similarly, the initial hematocrit value is not an indication for surgical exploration, as it tells little about the rate of ongoing bleeding. Indications for surgical exploration vary between authors, but reasonably conservative guidelines are as follows: hemodynamic instability despite adequate resuscitation; initial drainage of >1,500 mL; continued bleeding of >200 mL/h for 3 consecutive h; continued bleeding of >1,500 mL/d; and radiographic evidence of significant retained clot (>1/3 of the pleural space).

**Thoracoscopy for Hemothorax**

The role of thoracoscopy in the management of hemothorax is not fully defined. Thoracoscopy requires general anesthesia, single-lung ventilation, appropriate instrumentation, and the capability of proceeding immediately to thoracotomy.

Thoracoscopy has been used successfully in the trauma setting for patients who are hemodynamically stable with ongoing bleeding. Smith and colleagues performed thoracoscopy on five patients with ongoing chest-tube bleeding of >1,500 mL/24 h, identified intercostal vessel bleeding in all patients, and controlled three of five with thorascopic electrocautery; two patients required conversion to thoracotomy. Jones and colleagues used videothoracoscopy to assess 36 patients with persistent hemorrhage from penetrating trauma who had no other indication for immediate surgical exploration. The injury was identified in 35 patients, and thoracotomy was avoided in 16 (44%) who presented with >1,500 mL of drainage on admission. Intercostal bleeding was successfully controlled with electrocautery in 2 of 3 patients with ongoing bleeding. Liu et al successfully applied video-assisted thoracic surgery (VATS) in 50 hemodynamically stable patients with traumatic hemothorax or complications of retained hemothorax. Of these, 38% had penetrating trauma, 36% had inadequate
drainage of the hemothorax after blunt trauma, and 22% had ongoing bleeding from blunt trauma. Two thirds of the patients with penetrating trauma had negative findings on thoracoscopic explorations except for minor pleural tears.

These reports support the use of thoracoscopy in selected patients with traumatic hemothorax who warrant exploration for hemodynamically stable but ongoing bleeding. If chest-tube drainage results in good evacuation of the hemothorax radiographically and the rate of bleeding is less than the criteria outlined above, observation is appropriate. If there appears to be retained clot or continued bleeding at a greater rate, thoracoscopy allows minimally invasive early evacuation of retained clot, rapid evaluation of the injury, and potential control of the bleeding source without resorting to thoracotomy. Conversion to thoracotomy is easily done if the injury cannot be managed thoracoscopically.

**Residual and Clotted Hemothorax**

Small residual hemothoraces are often seen radiologically as blunting of the costophrenic angles. These are reabsorbed in about 1 month and rarely require intervention.

Large residual hemothoraces clot and cannot be drained with chest tubes. A clotted hemothorax may be defined as a residual clot that occupies at least 1/3 of the hemithorax or is estimated to be > 500 mL in volume. These are often sequelae of suboptimal management of the initial hemothorax. Additional chest tubes occasionally evacuate retained blood, but in most cases the blood has already clotted. Prolonged chest-tube drainage is of little use in these cases because clot liquefaction takes several months. Approximately 20% of patients with a hemothorax initially managed with tube thoracostomy continue to have a residual clot; about 40% of these require thoracotomy to evacuate these collections.

If initial chest-tube drainage does not appear successful on conventional radiographs, a chest CT scan is useful for distinguishing between a retained pleural collection (which may require surgical evacuation) and a parenchymal process, such as pneumonia or contusion (which requires supportive measures only). The volume of the collection, its degree of loculation and debris, and the relative position of chest tubes can be easily assessed. On occasion, a second chest tube or an image-guided percutaneous catheter can evacuate a solitary loculated fluid collection.

Surgical evacuation of a clotted hemothorax ought to be performed early. During the first 7 days, the clot is easily evacuated with little underlying entrapment of the lung. As the clot organizes thereafter, fibrin precipitates on all exposed surfaces followed by fibroblastic proliferation. The result is a mature fibrous peel, which entraps the lung. The lower lobe is most involved in these cases because of gravitational distribution of the blood. A more difficult decortication is required to reexpand the lung in these cases. Other complications of clotted hemothoraces include chronic atelectasis, pneumonia, and empyema. Empyema may arise from underlying pneumonia or colonize via the chest-tube tract. There is no evidence that the use of prophylactic antibiotics reduces the risk of empyema formation in this setting.

Fibrothorax, empyema, and chronic atelectasis are problems best avoided by early recognition of retained hemothorax and prompt surgical intervention.

Clotted hemothoraces can be successfully evacuated with thoracoscopy if this is performed within the 1st week. The morbidity and length of stay associated with thoracoscopy are less than thoracotomy, and this technique ought to be considered as soon as a retained hemothorax is recognized. Smith and colleagues
evacuated eight of nine clotted traumatic hemothoraces occupying \(>1/3\) of the hemithorax successfully with videothoracoscopy. Liu and colleagues\(^8\) resolved 19 clotted hemothoraces after blunt trauma with thoracoscopy alone. Meyer and colleagues\(^16\) prospectively randomized 39 patients with retained hemothoraces between a second tube thoracostomy or videothoracoscopy. Patients undergoing VATS had shorter duration of tube drainage and shorter hospital stays. Of the patients in the chest-tube group, 42\% required surgical evacuation of the hemothorax. Heniford and colleagues\(^17\) reviewed 25 patients with retained posttraumatic pleural collections (19 hemothorax and 6 empyema) treated with thoracoscopy. In patients in whom thoracoscopic drainage was unsuccessful, the mean time between admission and operation was 14.5 days; in patients in whom thoracoscopy succeeded, this period was 4.5 days.

When thoracoscopy fails, or the process is too chronic, thoracotomy is required to fully evacuate the clot and decorticate the lung where it is entrapped. Complete reexpansion of the lung is the objective. Decortication must be performed as early as possible (3 to 5 weeks), because eventually, fibrosis may extend into the lung and permanently limit its expansibility.\(^11\) In most series, the operative mortality is 0 to 5\%. Postoperative complications include peripheral air leaks and hemorrhage. Attention to meticulous surgical technique reduces the incidence of these problems. If the underlying lung parenchyma is normal, full reexpansion of the lung is almost always achieved. Recovery after a successful decortication is usually rapid. Residual radiographic findings, such as blunting of the costophrenic angles and pleural thickening, may take several months to resolve but are of little clinical significance.