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REVIEW

Treatment of haemothorax

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Summary
Haemothorax is a problem commonly encountered in medical practice and is most frequently related to open or closed chest trauma or to invasive procedures of the chest. Spontaneous haemothorax is less common and can have various causes, such as the use of anticoagulants, neoplasia, and rupture of pleural adhesions. Identification by radiography and thoracentesis is indicated and treatment of the underlying trauma should start immediately. After insertion of a large chest tube, antibiotic prophylaxis in trauma patients should be administered for 24 h.

Further treatment depends on the haemodynamic stability of the patient, the volume of evacuated blood and the occurrence of persistent blood loss. Surgical exploration by VATS or thoracotomy is necessary if >1.500 ml of blood has accumulated and/or an ongoing production of >200 ml of blood per hour is observed. If the haemorrhage is less severe, careful investigation into the underlying cause must be performed and blood should be evacuated by tube thoracostomy. If clotted blood retained in spite of tube thoracostomy, intrapleural fibrinolytic therapy can be applied to breakdown clots and adhesions. If conservative treatment is insufficient, a surgical approach with VATS or thoracotomy is indicated to prevent subsequent complications.

Contents

Abbreviations: CT, Computer Tomography; IPFT, Intrapleural Fibrinolytic Therapy; IU, International Units; VATS, Video-Assisted Thoracoscopic Surgery.

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Introduction

The exact incidence of haemothorax is not known. Chest injuries occur in approximately 60% of all polytrauma cases and haemothorax is most frequently caused by chest trauma. A rough estimate of the occurrence of haemothorax related to trauma in the United States approaches 300,000 cases per year.[1] Generally, haemothorax can be divided into two categories, based on aetiology: spontaneous and traumatic haemothorax.

This document represents the present knowledge about treatment of haemothorax looking at the published literature. We performed a systemic search of the literature, using the term "haemothorax" in PubMed. Articles published between 1975 and September 2009 were included.

Definition

Haemothorax refers to a collection of blood within the pleural cavity. By definition this bloody pleural effusion should contain a haematocrit value of at least 50% of the haematocrit of peripheral blood.

Aetiology

The primary cause of haemothorax is sharp or blunt trauma to the chest. Iatrogenous and spontaneous haemothoraces occur less frequently.

Iatrogenous haemothoraces are known to occur as a complication of cardiopulmonary surgery, placement of subclavian- or jugular-catheters or lung- and pleural-biopsies. Reported causes in the literature are, for example, sclerotherapy of oesophageal varices, rupture of pulmonary arteries after placement of Schwann—Ganz catheters, thoracic sympathectomy and translumbar aortography.[2]

Spontaneous haemothoraces are generally caused by rupture of pleural adhesions (3—7% of all cases), neoplasma (schwanommas, soft tissue tumours, and hepatocellular carcinoma), pleural metastasis, and as a complication of anticoagulant therapy for pulmonary embolism.[3] Less frequent causes reported in the literature are rupture of aneurysmatic thoracic arteries such as the aorta, mammarian arteries and intercostal arteries (e.g. Ehlers Danlos syndrome, and neurofibromatosis), rupture of pulmonary vascular malformations (Rendu-Osler-Weber syndrome), endometriosis, and exostoses.[2,3]

Pathogenesis

Bleeding into the pleural space can occur with virtually any disruption of the tissues of the chest wall and pleura or the intrathoracic structures. Blood that enters the pleural cavity is exposed to the motion of the diaphragm, lungs, and other intrathoracic structures. This results in some degree of defibrination of the blood so that incomplete clotting occurs. Within several hours of cessation of bleeding, lysis of existing clots by pleural enzymes begins. However, when this lysis is incomplete or bleeding is relatively large, clot formation is inevitably.

Once the clot has been allowed to organize, it will adhere to the lung and pleura, making it difficult to remove. The agitation of cardiac and respiratory movement rapidly defibrinates the blood, and a fibrin clot thus formed is deposited on the visceral and parietal pleura, setting the stage for a trapped lung. In its early development, this thin membrane has little substance and is attached very loosely to the underlying pleural surface. By the seventh day, there is an angioblastic and fibroblastic proliferation. The membrane continues to thicken by progressive deposition and organization of the coagulum within the cavity. An understanding of the pathologic features of a clotted haemothorax makes it clear that, if possible, the clotted haemothorax should be evacuated within a reasonable time after onset of bleeding.

Initial treatment

Chest tube drainage

In most cases, chest tube drainage by means of a large calibre ($\geq$28 French) tube is an adequate initial approach unless an aortic dissection or rupture is suspected.[2,3] After the tube thoracostomy is performed, a chest radiograph should always be repeated in order to identify the position

of the chest tube, to reveal other intrathoracic pathology and to confirm whether the collection of blood within the pleural cavity has been fully drained.

Surgical approach in the acute phase

The criteria for surgical exploration, as detailed in the literature, are blood loss by chest tube 1.500 ml in 24 h or 200 ml per hour during several successive hours and the need for repeated blood transfusions to maintain haemodynamic stability.[4–6]

Patients with active blood loss but with stable haemodynamics can be treated with Video-Assisted Thoracoscopic Surgery (VATS), not only to stop the bleeding but also to evacuate blood clots and breakdown adhesions. A series of 50 VATS procedures, performed in patients with traumatic haemothorax, demonstrated active blood loss in eleven subjects.[4]

Thoracotomy is the procedure of choice for patients with haemodynamic instability due to active bleeding.[2] Surgical exploration allows control of the source of bleeding and evacuation of the intrathoracic blood.

Prophylactic antibiotics

Antibiotic treatment following haemothorax reduces the rate of infectious complications.[7–10] The Eastern Association for Trauma developed guidelines based on nine prospective placebo-controlled studies, including several double blinded studies and two meta analyses. Most of the cases enrolled in these studies were penetrating chest traumas, but some studies also included patients with spontaneous haemothorax. The guidelines recommend the use of first generation cephalosporins during the first 24 h in patients treated with chest tube drainage for haemothorax. In the included studies however, a broad range of antibiotics was applied. When empyema occurs during chest tube drainage, antibiotic treatment should be directed to *Staphylococcus aureus* and *Streptococcus* species.[8]

In a comment on this guideline, results of different studies were combined to generate incidence rates. The authors concluded that prophylactic use of antibiotics during at least 24 h after the start of chest tube drainage for haemothorax, reduced the incidence of pneumonia from 14.8% to 4.1%.[9] The incidence of empyema decreased from 8.7% to 0.8%.

Another randomised controlled study, performed after the publication of these guidelines, also revealed fewer infectious complications in the group of patients treated with prophylactic antibiotics.[10]

The duration of antibiotic treatment remains a point of discussion and recommendations vary from 24 h to the moment of chest tube removal. In general, 24 h of antibiotic treatment is advised in traumatic haemothorax.[8] Whether antibiotic prophylaxis is useful for spontaneous haemothorax has not been investigated accurately.

Intrapleural fibrinolytic therapy

Intrapleural fibrinolytic therapy (IPFT) can be applied in an attempt to evacuate residual blood clots and breakdown adhesions when initial tube thoracostomy drainage is inadequate. Retention of blood in the pleural cavity may lead to lung entrapment, chronic fibrothorax, impaired lung function and infection. Several small non-randomised studies report on IPFT with streptokinase (250,000 IU), urokinase (100,000 IU or 250,000 IU) or tissue plasminogen activator (TPA).[11–16] The intervals between the day of onset of haemothorax and the start of treatment varied from 4 to 165 days. Whether IPFT can be initiated prior to the fourth day is not clear from the published reports. Generally, it is advised to evacuate the clotted haemothorax within 7–10 days.[4]

Reports on duration of treatment with IPFT vary between 2 and 9 days for streptokinase and 2–15 days for urokinase.

In most cases, treatment with IPFT leads to complete resolution of radiographic abnormalities, through evacuation of blood clots and loculated effusions. Less than 10% of cases need a more aggressive treatment by means of surgical decortication.

Bleeding complications due to a possible systemic effect of fibrinolytic substances were not reported in the studies using streptokinase and urokinase. A study using recombinant tissue plasminogen activator as a fibrinolytic agent, was reported on one patient who developed haematuria requiring blood transfusion.[16]

The relationship between the time frame of IPFT or conversion to surgical intervention and the risk of developing long-term complications has not been established in the published literature.

If chest tube drainage and IPFT does not lead to sufficient resolution of the retained clots, surgical intervention should be considered.

Surgical approach in a later phase

VATS

Optimal evacuation of residual clots, breakdown of adhesions and loculated effusions is important in order to prevent a complicated course leading to empyema or fibrothorax. A volume of 500 ml of blood or an amount of blood filling one third of a hemithorax is considered an indication for surgery.[17–20]

Chest X-ray seems to be an inadequate tool in establishing the indication for VATS. The surgical procedure should therefore be preceded by computer tomography (CT), to be able to detect locations and residual clots with high accuracy.[18,21,22]

The estimated amount of fluid on CT scans has been shown to correlate very well with the true amount of fluid harvested by VATS.[22]

VATS evacuation of the haemothorax or retained clot can be performed safely. One-lung ventilation is not required. A single lumen tube can be used with directions to anaesthesiologist to decrease tidal volume or intermittently hold ventilation during the procedure. If cardiac, great vessel, or tracheobronchial injury is found, conversion to thoracotomy can be performed expeditiously.

A randomised study in patients with incomplete resolution of clots and blood after chest tube drainage reported

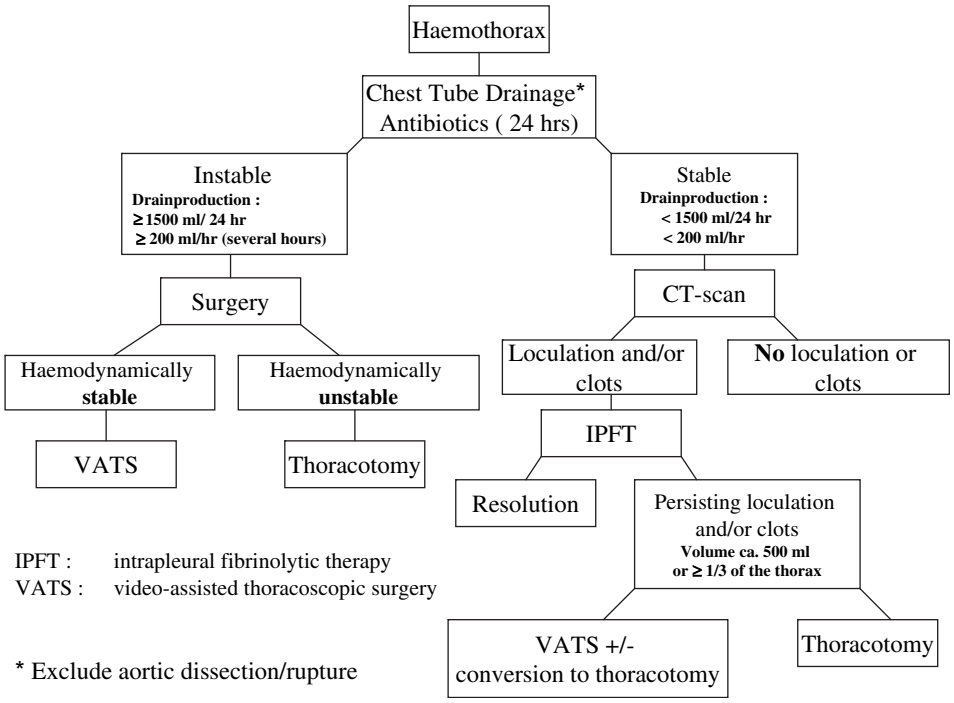

Figure 1 Algorithm of therapeutic approach of traumatic haemothorax and spontaneous haemothorax.

shorter length of hospital stay and shorter duration of tube drainage in a group of patients treated with VATS as compared to a group treated with additional tube drainage.[17]

Several prospective and retrospective non-randomised studies in small groups of patients show favourable results of VATS (80%—100%) with high effectiveness and low morbidity.[6,19—21,21—26]

However, the methods of evaluation were not reported in all of these studies and IPFT was not integrated in the therapeutic strategy. An optimal period between trauma and VATS of 48—72 h is repeatedly advocated, although a longer interval is more common.[6,19,21,26]

Longer intervals between the start of haemothorax and VATS lead to increased rates of complications, according to some authors.[19,20]

Thoracotomy

Thoracotomy is the procedure of choice for surgical exploration of the chest when massive haemothorax or persistent bleeding is present. At the time of surgical exploration, the source of bleeding can be controlled and a haemothorax evacuated. Thoracotomy is usually required for adequate empyema drainage and/or decortication. In 10% of cases a thoracotomy is necessary to treat the haemothorax.[6]

A longer time span between the appearance of haemothorax and VATS increases the chance of intraoperative conversion to thoracotomy, prolongs postoperative drainage time and is associated with a higher incidence of hospital admissions.[19,27] When haemothorax is complicated by empyema, the duration of hospital stay also increases.[19]

Algorithm

Based on the information derived from the literature, an algorithm was designed to be used in the approach of patients with haemothorax (Fig. 1). At first, laceration of blood vessels and other leaking vessels (e.g. aortic aneurysm, lobar sequestration, and arteriovenous malformation) should be excluded radiographically.

Secondly, blood should be evacuated immediately following tube thoracostomy. In haemodynamically unstable patients inspection and drainage of the pleural cavity by thoracotomy is indicated, whereas in haemodynamically stable patients VATS is considered the treatment of choice. In residual haemothorax, IPFT, with daily application of streptokinase, urokinase or TPA, is indicated for local fibrinolysis. If treatment with IPFT is not successful, surgery is the treatment of choice to prevent development of pleural thickening and fibrosis.

In patients with traumatic haemothorax antibiotic prophylaxis 24 h is indicated.

Because the literature does not provide data for an optimal time frame between IFPT and VATS, we chose to abstain from providing one in the algorithm. It appears logical to commence chest tube drainage followed by IPFT before proceeding to VATS if there is residual blood in the thorax.

Although fibrinolytic treatment was initiated at least 4 days after the onset of haemothorax in most trials, it is probably safe to start earlier in the course of treatment. Intrapleural deposition of fibrinolytics is not very likely to cause systemic effects.[28] IPFT is not indicated when coagulopathy or vascular lesions (e.g. angiosarcomas, pulmonary vascular malformations, and aneurysms) may be present.

Conclusion

Haemothorax is a relatively common problem, most often resulting from injury to intrathoracic structures of the chest wall. Non-traumatic haemothorax can be a complication due to various causes. Rapid identification of the cause and initiation of treatment is essential. In haemodynamically unstable patients tube drainage and surgery is indicated. In haemodynamically stable patients evacuation of blood from the pleural cavity by chest tube with or without IPFT should be performed. If this treatment is not successful, surgery is indicated in order to prevent long-term complications and impaired pulmonary function.

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None.

Conflict of interest

None declared.

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