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REVIEW ARTICLE

TREATMENT OF HEMOTHORAX IN THE ERA OF THE MINIMALY INVASIVE SURGERY

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Summary

Hemothorax is a frequent clinical situation often associated with chest injury or with iatrogenic lesions. Spontaneous hemothorax is uncommon and among its cause may include coagulation disorders, pleural, pulmonary or vascular pathology. Diagnostics is based on radiography or ultrasound and thoracentesis which may be also therapeutic solution. The majority of hemothoraxes can be managed non-operatively but hemodynamic instability, the volume of evacuated blood and persisting blood loss or persisting hemothorax require surgery. A surgical approach may vary from open thoracotomy to rapidly developing minimally invasive methods - video-assisted thoracoscopic surgery (VATS) and videothoracoscopy (VTS).

Key words: hemothorax; surgery; VATS; thoracotomy

Introduction

Hemothorax is a pathological collection of the blood within the pleural cavity. Hemothorax most frequently origin in a thoracic injury but the exact incidence is not known. The reported incidence of chest traumas varies according to authors and institutions (1, 2). Published rough estimate of the traumatic hemothorax occurrence in the United States came up to 300 000 cases per year (3).

The aim of this article is to describe the current approach to diagnostics, management and operative techniques of the hemothorax. Employing the electronic databases MEDLINE, Pubmed and Ebscohost, was performed a systematic search of the term " hemothorax" in the articles of the last 3 decades.

Etiology

Based on etiology hemothorax can be divided into traumatic and spontaneus. Dominate cause of hemothorax is chest trauma, most often chest wall blunt trauma with bone injury and penetrating chest injury (4, 5).

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Iatrogenous hemothorax is a distinctive trauma which can occur as a complication of subclavian and jugular cannulation, pleural puncture and lung biopsies or as a complication of cardiothoracic surgery. There were published several reports describing this complication after permanent pacemaker implantation, laparoscopic surgery, transjugular liver biopsy, coronary angiography, translumbar aortography, radiofrequency ablation for lung and liver tumors or oesophageal varices sclerotherapy (6-9).

Spontaneous hemothorax has a heterogenous etiology. It can be caused by pleural pathology - rupture of pleural adhesions, endometriosis, primary tumors or metastasis; pulmonary pathology - bulous emphysema, primary and secondary tumors, pulmonary vascular malformation, necrotic infection or tuberculosis; by vascular pathology - rupture of aneurysmatic thoracic aorta, intercostal arteries or aneurysmatic mammarian vessels; abdominal pathology - pancreatic pseudocysts, hemoperitoneum, subdiaphragmatic tumors; blood coagulation disorders - thrombocytopenias, haemophylia, hemorrhagic fever, hypocoagulation due tu anticoagulant therapy (6,9-13).

Pathogenesis

According to volume can be hemothorax divided to: small - less than 400 ml of blood; average - 500 to 1500 ml; large - more than 1500 ml (9).

Any of the tissues of the intrathoracic organs and structures or the thoracic wall can be source of bleeding into the pleural cavity. Blood within pleural space is exposed to the movement of the heart, lung and diaphragm and this causes certain level of the blood defibrination with incomplete clotting. A small hemothorax is usually resorbed within several days in majority of the patients. In case of large hemothorax clots persists (5, 9).

Persistent clots adhere to the pleura and lungs and when has been organized it will be not accessible neither to evacuation nor to chest drainage. The respiratory and cardiac motion promptly defibrinates the blood and hereby formed fibrin clot is deposited on the both pleuras, visceral and parietal, setting the stage for fibrothorax. In its early development has thin membrane a little substance and is attached very loosely to the underlying pleural surface. After one week continues the membrane to thicken by the angioplastic and fibroblasic proliferation with progressive deposition and organisation of the coagulum within the cavity. This should exhort to evacuate the clotted hemothorax within a reasonable time after onset of bleeding (5, 9).

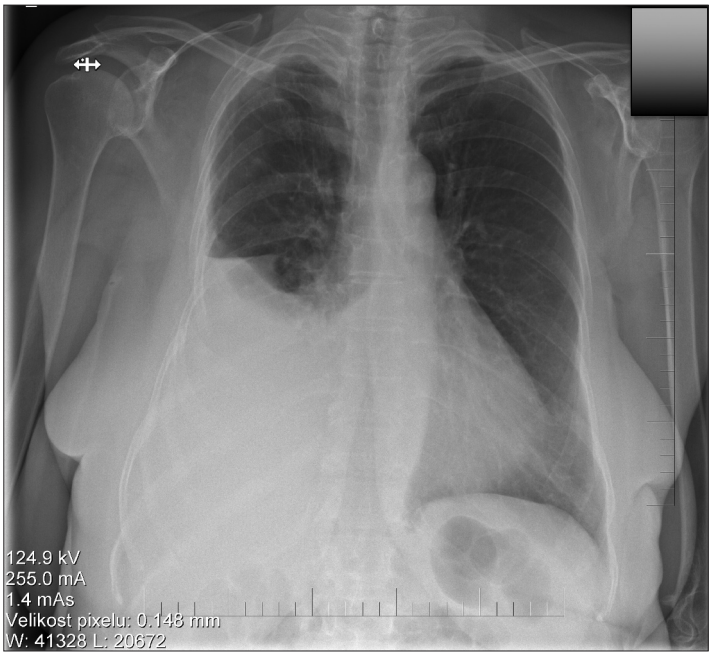

Figure 1. Right Sided retained post-traumatic hemothorax.

Symptoms

The clinical presentation of patients suffering by bleeding to thoracic cavity is depended to volume and rapidity of blood loss. A small bleeding might be asymptomatic. Increasing blood loss may present with symptoms and signs of hypovolemia and may result to cardiopulmonary arrest. Patients with thoracic injury might have a symptoms of pneumohemothorax, open pneumothorax or may present with a tension pneumothorax and rarely they may present with symptoms and signs of pneumomediastinum (1, 4, 14).

Diagnosis

CHEST X-RAX is essential and also the most frequently used radiological modality in diagnostics of hemothorax. Chest X-Ray approves the presence of fluidothorax/pleural fluid collection. A supine posteroanterior and lateral projections are mandatory (Figure 1) (1, 2, 4, 9, 14, 15).

CHEST ULTRASOUND can be rapidly performed by the physician carrying out the initial evaluation of the afflicted patient. The FAST (Focused Assessment Sonogram for Trauma) is a standard part of the secondary trauma survey and except exclusion of consequent cardiac injuries it can diagnose a pleural fluid collection. Conventional transthoracical ultrasonography is a reliable modality for the diagnosis of hemothorax, pneumothorax or pneumo-hemothorax (16).

The increased use of *COMPUTED TOMOGRAPHY (CT)* in the evaluation of hemothorax and mainly in the evaluation of acute chest trauma has improved diagnostic sensitivity. CT scans are able to detect the pulmonary and thoracic wall pathologies as well as the presence of associated thoracic and mediastinal vascular lesions (Figure 2) (1, 3, 4, 14,15,17).

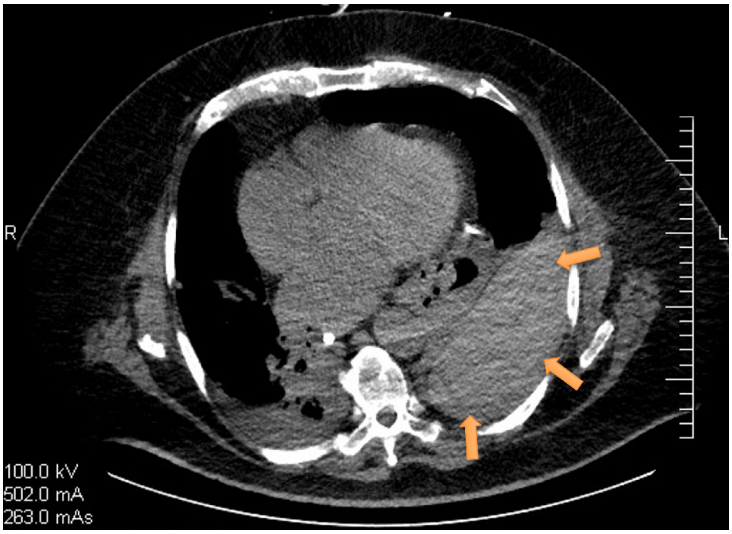

Figure 2. Left Sided retained post-traumatic hemothorax (orange arrows).

Treatment

Initial Treatment – Thoracostomy.

Thoracostomy - chest tube drainage may be diagnostic as well as therapeutic modality (1, 4, 9). Chest tube placement of an appropriate drain ($\geq$ 28 French) is an adequate initial approach (5). It will evacuate and quantify the hemothorax, in case of associated injuries it will evacuate air, detect air leaks and may determine an indication for thoracotomy (1-5, 9, 14). Chest X-ray should be always repeated after the drainage to confirm the chest tube position, to detect other chest pathologies and to qualify the effectiveness of the drainage (5).

Acute Surgical Management

The indication to surgical exploration is determined by following criteria: blood loss by chest tube 1500 ml and more in 24 h or 200 ml per hour in next 5 h and the need for repeated blood transfusions (1-5, 9, 10, 14).

Hemodynamically stable patients with active bleeding can be cured with minimally invasive methods - VATS or in some cases with VTS. These methods directly and accurately evaluate the lung, diaphragma surface and mediastinum with possibility of simultaneous treatment of cause and with precise blood clots removal and adhesions breakdown to prevent and solve a potentional long term complication (1, 4, 5, 18, 19, 40-42).

For hemodynamically instable patients with active bleeding the thoracotomy is the method of choice to gain surgical hemostasis and for evacuation of blood and clots from the pleural cavity(1-5).

Intrapleural Fibrinolytics Therapy

Intrapleural fibrinolytics therapy is used to evacuate blood clots and for disruption of adhesions if the thoracic drainage is not satisfactory or in patients where surgery is contraindicated. The most common indication for fibrinolytics therapy is uninfected clotted hemothorax of smaller size. As the fibrinolytics, there are used streptokinase (250 000 IU), urokinase (100 000 IU or 250 000 IU) or tissue plasminogen activator (20, 21).

Generally, it is advised to evacuate the clotted hemothorax within 7-10 days (36). Then the organization of fibrin occurs and the treatment is unsuccessful. Treatment time differs from 2 to 9 days for streptokinase and from 2 to 15 days for urokinase. If the treatment of coagulated hemothorax is not successful after four weeks and the clot inhibits developing of lung, the surgery is indicated (5).

Antibiotic Prophylaxis

The main aim of prophylactic antibiotic use is a reduction of infectious complications - primarily empyema and then bacterial pneumonia and their associated morbidity. Guidelines for usages were developed based on nine prospective placebo-controllled studies by The Eastern Association for Trauma. In general, it shoud be used antibiotics with a narrow spectrum of activity focused against the most common organisms (22-24). The duration of treatment stays the question and it is still discussed. The range reaches from 1 day to the moment of chest tube withdrawal. Generally, 24 h of antibiotic treatment is advised in traumatic hemothorax (5, 22-24). Benefit of antibiotic use in spontaneous hemothorax has not been adequately researched.

Surgical Approach In Retained Hemothorax

Retained hemothorax is associated with high rates of empyema and pneumonia. Target of the surgical therapy is evacuation of residual hemothorax and dividing of adhesions to prevent complications which could lead to pyothorax or fibrothorax. Hemothorax 500 ml and more or an amount of blood filling one third of a hemithorax is considered as an indication for surgery (5, 26).

In the preoperative examination the Chest X-ray alone is not adequate in setting of the indication for VTS/VATS. The CT should be preceded before the surgery. CT is able to detect with high accuracy the locations and volume of retained clots with residual hemothorax (55, 26).

Minimaly Invasive Surgery (VTS, VATS)

The method of choice for stable patients is the use of minimally invasive surgery - VTS/VATS (27). VATS evacuation of the retained clot and the residual hemothorax can be performed safely. Standard approach is a procedure in the selective biluminal lung ventilation with collapsed lung at the ipsilateral side (57-59). A single lumen tube can be used in selective clinical circumstances (5). If there is cardiac, tracheobronchial or great vessels injuries found, conversion to thoracotomy should be performed promptly (Figure 3).

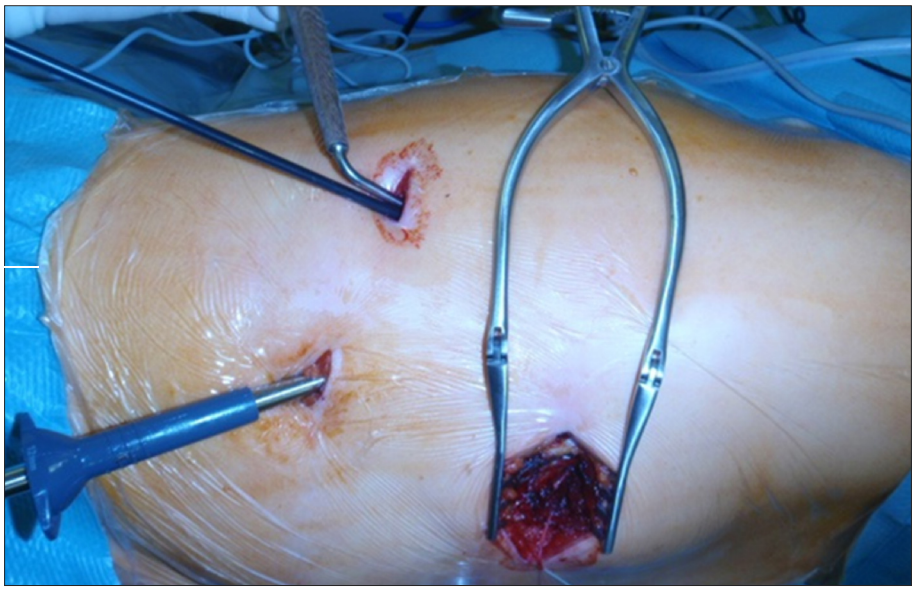

Figure 3. VATS (Video Assisted Thoracic Surgery) – incision position.

A randomised studies in patients with retained hemothorax and incomplete resolution of clots after the thoracostomy reported 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 chest tube drainage (26,28).

Several prospective and retrospective non-randomised studies showed favourable results of VATS (80% – 100%) with high effectiveness and low morbidity (26,28). The multicenter prospective observational trial conducted by An American Association for the Surgery of Trauma with 328 patients in study showed that VATS can be performed with high success rates although 25% of patients required at least two procedures to effectively clean up of retained hemothorax or subsequent infections of pleural space (26). Most quoted optimal period between trauma and VATS is 48–72 h, although a longer interval is more common (26, 28). According to some authors longer intervals between the outset of hemothorax and surgery lead to increased rates of complications (Figure 4 and 5) (26).

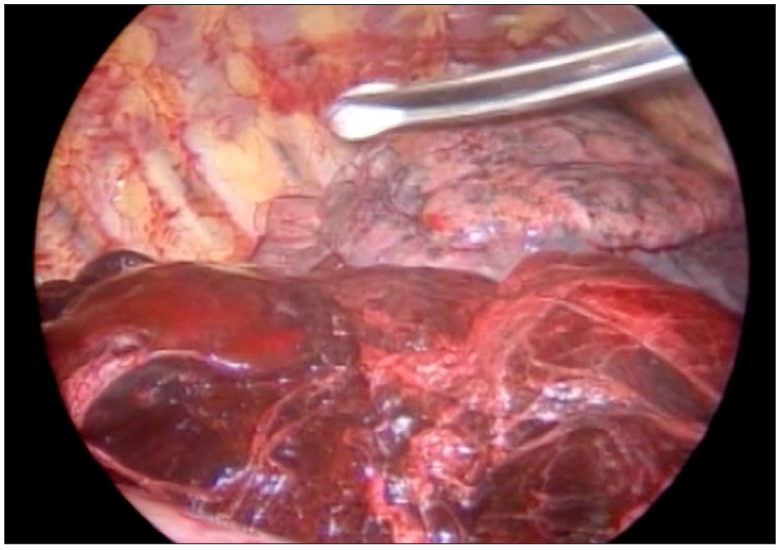

Figure 4. Right Sided retained post-traumatic hemothorax (videothoracoscopic evacuation).

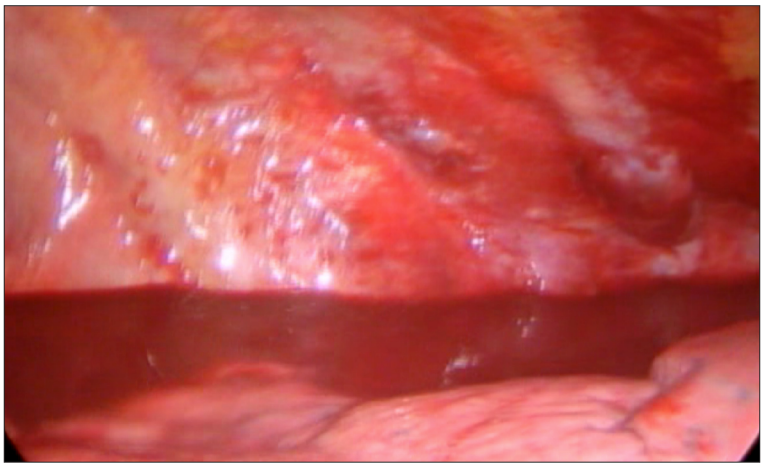

Figure 5. Right Sided post-traumatic hemothorax (videothoracoscopic evacuation).

Thoracotomy

Thoracotomy is the procedure reserved for the surgical exploration of the affected pleural cavity in the case of massive hemothorax or persistent bleeding. During the procedure hemothorax is evacuated with synchronous control of the bleeder. Thoracotomy is also mostly need for decortication of the trapped lung and to achieve an efficient drainage of empyema (5, 9). In case of traumatic retained hemothorax 20.4% of patients required thoracotomy (26).

Last not least, thoracotomy is also need in case of contraindication or technical impossibility of mini-invasive approach (inability of one lung ventilation, extensive pleural adhesion, defunct slots between the lobes).

A longer period of time between the appearance of hemothorax and VATS in hemodynamically stable patients increases the rate of conversion of VATS to thoracotomy, increases the incidence of postoperative complications, prolongs duration of chest tube drainage time and drainage volume and it is associated with longer duration of hospitalization (5, 26, 27).

The perioperative mortality rate was not significantly different between patients received VATS and open thoracotomy (58).

Conclusion

Hemothorax is relatively frequent clinical situation, most often associated with thoracic trauma followed by iatrogenic injury. Spontaneous hemothorax is rare with variety of causes. The key to effective treatment is a rapid diagnostics of the source and consequent rapid initial treatment. Hemodynamically unstable patients are indicated to urgent thoracentesis and surgery. Patients with hemodynamic stability are initially treated non-operatively by chest tube to evacuate blood from the thoracic cavity and surgery is a troubleshooting in case of persisting hemothorax or persisting blood loss. A surgical approach may vary from minimally invasive methods - VATS and VTS to open thoracotomy and except the control of bleeder surgery should prevent and solve a potential long term complication.

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Conflict of Interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

Adherence to Ethical Standards

This article does not contain any studies involving animals performed by any of the authors.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants involved in the study.

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