

Management of Pleural Empyema in the Setting of an African Country: An Article Review

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Abstract

Pleural empyema (PE) (also known as a pyothorax or pleural pleuritis) is the presence in the pleural cavity of a fluid of frankly purulent appearance seen after thoracocentesis or a fluid of other appearances containing a major of altered neutrophils or germs in the microbiological test. The PE has several causes and its rate was significantly decreased owing to discovery of many antibiotics products. PE constitutes a diagnostic and therapeutic emergency, because it can be life threatening for the patient in the acute phase and implies pulmonary sequelae in the late phase. The aim of medical treatment is to avoid the evolution to the organizing stage where the surgical treatment is mandatory.

Keywords: *Pleural Empyema; Thoracostomy; Surgery; Decortication*

Definition and pathophysiology

Pleural empyema (PE) (also known as a pyothorax or pleural pleuritis) is the presence in the pleural cavity of a frankly purulent fluid appeared during thoracocentesis or a fluid of other appearances containing a major of altered neutrophils or germs in the microbiological test [1]. According to this definition, thoracocentesis is a key procedure to differentiate between pleural empyema and other pleural effusions.

In a general way, PE evolves according to three pathological stages that extend from 6 weeks to 8 weeks after dissemination of infection in pleural cavity and the subsequent pleural reaction:

- **Exudative (early) stage [3]:** This stage can be continued from 3 to 7 days after pleural reaction. It is a purely an inflammatory process in which pleural membranes become edematous responsible of an increase in permeability of small blood vessels driving to exudation of fluid in the pleural space. This fluid is very thin, with a low cellular content and an underlying lung that expands readily.
- **Fibrino-purulent stage [4]:** It can be continued from 7 to 21 days and known by constitution of fibrin that is deposited along the pleura membranes especially at the level of parietal pleura. Empyema fluid becomes now more thicker and turbid, with a high white cell count. There are tendency towards loculation and formation of pouches in the pleura.

- **Organizing (chronic) stage [5]:** This stage can take from 3 to 6 weeks. Fibrinous layers start to organize as collagen and become vascularized by ingrowth of capillaries. Empyema cavity becomes surrounded by cortex and contains frank pus. Pachypleuritis of pleura membranes exerts a restrictive effect driving to the compression the underlying lung (trapped lung effect), and subsequently to thoracic deformity by retraction of intercostals spaces.

The management differs according to this classification of pleural empyema. In a global way, the exudative and fibrino-purulent stages can be managed by only a medical treatment without surgery if this treatment is well conducted. However, in the stage of organization of the pleural empyema, surgical management remains mandatory owing to the constitution of pachypleuritis that practices a compressive effect on the underlying lung, and the medical management will never remove this pachypleuritis.

Etiologies

Causes of PE are multiples and can be of pulmonary origin, pleural or sub-phrenic origin. Tuberculosis constitutes the first cause of PE in Morocco. It still presents a public health problem despite efforts made to combat this disease. since tuberculosis is transmitted by air, the first affected organ remains the lung, and the pleura ranks second [6]. Pleural effusion firstly is exudative and no infected, after if the management is not performed in acute way, pleural empyema is occurred. The mechanism can be a rupture of a tuberculous cavern in the pleural space, a tuberculosis pleural abscess, or infection of a tuberculous pleural effusion by as example a repetitive thoracocentesis with lack of asepsis.

In the second position, we find PE caused by hydatid cyst broken in the pleural space, because hydatidosis disease remains an endemic pathology in our country. This rupture is either of a pulmonary hydatid cyst or a pleural hydatid cyst. Also, cases of hydatid cyst of liver broken in the pleural cavity were reported in our context [7]. Parapneumonic PE is the main cause in the developed countries [8]. This affection is secondary to pneumonia with contamination of the visceral pleura responsible of pleural reaction and as a result infected pleural effusion. PE can be caused by aspergillosis that can occur according to pleural sequelae of old tuberculosis or following invasive aspergillosis of lung especially in immunocompromised patients [9]. Closed or opened chest trauma is also a frequent etiology of PE. The mechanism of infection is explained by direct inoculation of the pleural cavity, superinfection of clotted hemothorax or seldom oesophageal perforation.

PE after thoracic surgery is more frequent when an anatomical lung resection is performed. The risk is especially increased more after pneumonectomy than after lobectomy [10,11]. Many risk factors were highlighted in the occurrence of postoperative empyema such as surgery for infectious lung disease (bronchiectasis, destroyed lung), completion pneumonectomy, and surgery of the right side [12]. PE can be the result of evolution of a lung cancer, either after chemo or radiotherapy, or after anatomical lung resection, or infection of a pleural effusion secondary to the metastatic lung cancer [13]. Also, PE can be the result of subphrenic diseases, mainly hepatic abscess, pancreatitis, diaphragmatic hernia or abdominal surgery [14].

Diagnosis

Clinical manifestations

Clinical manifestations depend on the abundance of the pleural effusion, nature of the infecting organism, and competence of the patient's immune system. These manifestations range from complete absence of symptoms to severe illness with septic shock's symptoms. In a general way, the main symptom remains chest pain and cough occurring at the change of position when the pleural effusion is not yet organized in the pleural space. Dyspnea is the result of an abundant PE with complete or incomplete atelectasis of the underlying lung. Clinical presentation in patients seen in the acute phase is made of fever, polypnea, chest pain, a poor general condition and sometimes septic shock's symptoms in cases with poor immune deficiency. Physical examination can find a decreased or absent breath sounds, dullness to percussion, or decreased tactile fremitus. In chronic PE, retracted hemithorax can be found or percutaneous fistula.

In the setting of our experience in the department of thoracic surgery, generally all patients have already been seen by pulmonologists, before addressed in our department for surgical management. For that, clinically the hemodynamic and respiratory conditions of patients are stable, with presence or not of chest tube drainage.

Chest X-ray, thoracic ultrasonography and computed tomography (CT)

Presentation on the thoracic imagery depends on the stage of PE and its abundance. In the exudative and fibrino-purulent stages, the chest X-ray shows a basithoracic opacity effacing the costo-diaphragmatic recess, limited superiorly by a concave line at the top and inside testifying to the free character of pleural effusion. When this pleurisy is abundant, white hemithorax can be shown. In the stage of organization of the PE, we can have a basithoracic opacity with a vertical line witnessing the presence of a pachypleuritis with a retraction of intercostal spaces (Figure 1). Thoracic ultrasonography is an easy, non-traumatic, non-exposing to radiations, and that can be performed on the patient's bed and in intubated patients. It allows the distinction between an elevated diaphragmatic cupola and sub-pulmonary pleural effusion. Also, this imagery allows guiding a thoracocentesis or thoracic chest tube drainage especially in organizing PE.

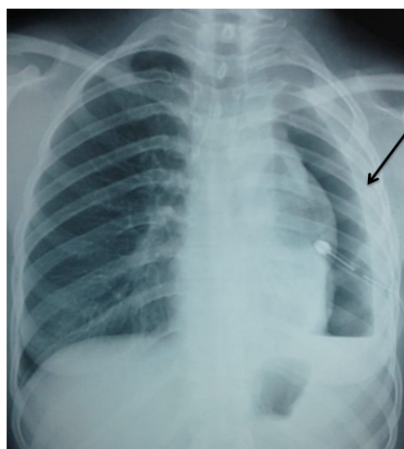


Figure 1: chest X-ray shows left pleural empyema with pouche and pachypleuritis (black arrow).

Thoracic CT with contrast injection determines the stage of PE by objectifying a free pleural effusion in the pleural space, pachypleuritis which catches contrast product, or presence of fibrino-purulent debris or pouches. This examination allows also the elimination of other diagnosis especially a pulmonary hydatid cyst that doesn't catch the contrast product in its walls. In addition, thoracic CT searches underlying causes of PE by analysis of airway and parenchymal structures (bronchial obstruction, lung consolidation, pulmonary nodule, tuberculous cavern...).

In our department, chest X-ray and thoracic CT are systematically performed in all patients. Thoracic CT before surgery allows anticipating the type of surgery and the expected difficulties. In a general way, thoracic ultrasonography is required for patients in order to guide thoracocentesis or chest tube drainage.

Biological tests

Biological tests request is made especially according to clinical presentation. Blood cell parameters and C-reactive protein are done to search a leukocytosis and to be oriented towards the presence of infection. Search of mycobacterium tuberculosis in the sputum test is performed systematically in all patients owing to endemic character of tuberculosis and to confirm presence of associated pulmonary

localization of this disease. Pancreatic enzymes and liver function tests are performed if suspicion of a sub-diaphragmatic origin of PE. For detection of a renal amyloidosis because of chronicity of necrotizing PE, we require systematically renal function test and urine analysis for proteinuria [15]. Serum electrophoresis can be performed in order to search a malnutrition.

Thoracentesis and closed needle pleural biopsy (CNPB)

Thoracentesis like as CNPB are performed by a pulmonologist under local anesthesia with aseptic measures, under the tip of scapula. Thoracentesis is performed by simple needle, however closed needle pleural biopsy is performed most commonly by Abrams needles [16,17]. These procedures are required to have diagnosis of the pleural effusion and perform an early treatment of PE in order to avoid occurrence of necrotizing stage. Thoracentesis discovers the macroscopic appearance of pleural effusion which is frankly purulent in case of PE, and perform biochemical, cytological and bacteriological tests [17]. PE is usually an exudative fluid with presence of altered polynuclear cells. Owing to endemic form of tuberculosis in Morocco, search of mycobacterium tuberculosis in the pleural fluid is required in all patients by Genexpert test. The diagnostic yield of CNPB is high in cases of pleural tuberculosis and malignancy. When this procedure is performed by experienced pulmonary physician, it becomes an important diagnostic tool that provides diagnosis with very low complication rates [16].

According to the clinical presentation, thoracic imagery, thoracentesis and CNPB, and biological tests usually the diagnosis is found and confirmed in all patients. In our daily practice, all patients with PE are seen after development of pachypleuritis, and thoracoscopy remains difficult in these patients because there is no space to place the trocars in the pleural cavity.

Fiberoptic bronchoscopy

This procedure should not be performed routinely in the context of PE [18]. It is more required in case of presence of associated hemoptysis, in smoking patients, and identification of a bronchopleural fistula especially in the setting of postoperative empyema after pneumonectomy or lobectomy. It seems more appropriate to perform fiberoptic bronchoscopy after chest tube drainage in order to avoid presence of passive atelectasis of parenchyma, and after thoracic CT in order to search lesions in the bronchial tree allowing the guide of the fiberoptic bronchoscopy.

Complications of PE

When the PE is not well managed or diagnosis in a late stage, it can lead to several complications. In the acute phase, the main complication remains the evolution to a septic shock that can be life threatening for the patient. In the late phase, especially after organizing stage, chronic compression of lung due to pachypleuritis impedes to ensure the function of hemostasis and leads to bronchiectasis and paracatricial emphysema of the underlying lung. The non-ventilation of lung and parietal pachypleuritis conducts to retraction of intercostals spaces and horizontalization of ipsilateral diaphragmatic cupola. These anatomical modifications can lead to frank thoracic deformity. Presence of PE after pneumonectomy or lobectomy leads to the opening of the bronchial stump and as a result installation of bronchopleural fistula that can be complicated by spillage of the contralateral lung [19]. In addition, PE can be responsible of occurrence of empyema necessitans that is defined by the presence of pus at the level of chest wall caused by diffusion of purulent fluid through intercostal space to soft tissue [20]. Chronic PE can evolve to calcifications of pachypleuritis that can contra-indicate any surgical procedure owing to high rate of mortality (Figure 2) [21]. This empyema necessitans is complicated later by percutaneous fistula especially in case of PE of tuberculous origin. In the kidney, the deposition of inflammatory proteins can lead to renal amyloidosis that conducted to death in one patient in our department [22].

Medical management

Goals of medical management

Despite the therapeutic management of patients with PE is not consensual throughout the world, and the approaches differ between medical teams and hospital centers, the goals are the same. The main aim is to obtain sterilization of the pleural space by prescription

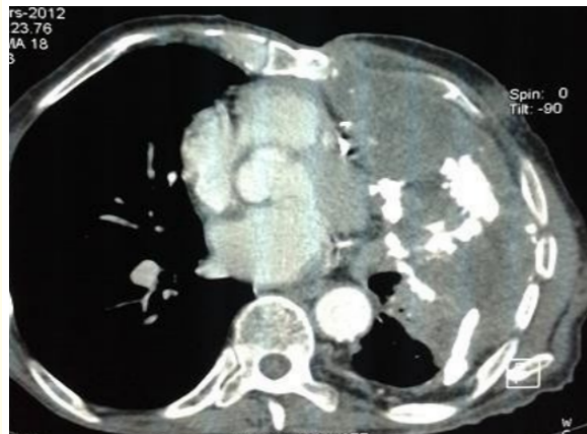


Figure 2: Thoracic CT showed a calcified pleural empyema with retraction of the underlying hemithorax.

of an appropriate antibiotic, evacuate this space of the purulent fluid by chest tube drainage, and recover the initial lung re-expansion by respiratory physiotherapy. These medical procedures are performed in order to avoid the evolution towards the necrotizing PE and pachypleuritis that involve a surgical intervention.

Antibiotics and anti-tuberculosis treatment

Antibiotic treatment is indicated in order to sterilize the pleural cavity and underlying pulmonary pneumopathies. This therapeutic option must be performed after a thoracentesis. Firstly, antibiotics must cover all germs that may be involved in the PE (common community-acquired bacterial pathogens and anaerobic organisms), after should be targeted according to the bacterial profile and the culture result [23]. These antibiotics are administrated initially by intravenous injection in order to allow a well diffusion in the pleural membranes, after according to clinical evolution and biological tests, they can be changed to oral administration. According to guidelines of American Association of Thoracic Surgery (AATS) and British Thoracic Society (BTS), aminoglycosides must be avoided in the management of PA, and also there is no indication for intrapleural administration of antibiotics in the PE [23,24].

Because that PE in our situation is due in first line by pleural tuberculosis, anti-tuberculosis treatment presents a well therapeutic option in these patients. Duration of treatment is 9 months but may be extended according to clinical and radiological response. When surgery is indicated in these cases, we decide surgical procedure after that patient is presented with a negative result of mycobacterium tuberculosis in the sputum.

Chest tube drainage

When the diagnosis of PE is confirmed, chest tube drainage must be performed in order to have a control of local infection and sterilize the pleural cavity. In the exudative and fibrino-purulent stages, the pleural effusion is free in the pleural cavity, and usually chest tube drainage is introduced in the middle axillary line. However, some cases with necrotizing PE can be presented with pouches that require an anterior or posterior thoracostomy. this closed thoracostomy must be done under local anesthesia with aseptic measures after a puncture of the pleural space. Empyemas occurring after pneumonectomy are performed in the medioclavicular line at the level of second or third intercostal space, because of the anatomical modifications after this anatomical lung resection. Concerning antibiotics administrated into the pleural space, there is no evidence that they increase the clearance and sterilization compared to systemic antibiotics alone [23]. ALSO, according the guidelines of AATS, intrapleural fibrinolytic therapy should not be used routinely for complicated PE [23].

In our daily practice, we perform chest tube drainage with chest drain of Joly CH24 (sometimes CH28), which is presented with two holes. To increase the efficiency of thoracic drainage and to ensure a maximum evacuation of purulent pleural effusion, we add additional holes (2 to 3) in the drain (Figure 3). In some patients, mobilization of the chest tube can be required, and this mobilization must be performed attentively in order to not place the distal hole of chest tube in the extrapleural region. After that patient benefit of chest tube drainage, this later is connected with suction system in order to attain the maximum evacuation of the PE.

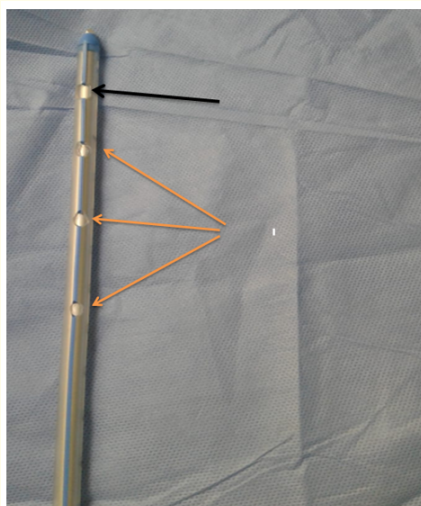


Figure 3: Black arrow: last distal hole found in Joly's drain, orange arrow: three holes added in the drain to increase its effectiveness.

Nutrition and respiratory physiotherapy

Because of the compressive effect of PE on the underlying lung, chest physiotherapy is required in the goal to maintain pulmonary function and prevention or reduction of respiratory complications. This chest physiotherapy improves bronchial drainage in order to remove the airway secretions [25]. Well chest physiotherapy is conditioned by an efficient analgesic treatment because of chest pain due to tube thoracostomy. Patients with PE often have malnutrition owing to chronic infection. A hyperprotid and high-calorie diet in these malnourished patients is recommended to avoid further complications. In our department, these therapeutic options (chest physiotherapy, hyperprotid and high-calorie diet) are usually recommended for all patients [7,9,15].

Surgical management

Even if that patient will be face to surgery because of the chronicity of PE, we prefer to perform chest tube drainage and antibiotics in order to decrease the risk of postoperative complications, especially infectious complications and bleeding. All patients must benefit of a preoperative chest physiotherapy and preparation for the surgery by arrest of smoking, taking more weight by hyperprotid and high calorie diet. Surgical procedure and expected complications should be well explained to patient in order to participate to chest physiotherapy in the postoperative period.

In our experience, all patients were benefited of an open thoracotomy in order to perform decortication, and any patient had benefited of a video-assisted thoracoscopy surgery (VATS) because patients are followed for many days, and sometimes for many months in the department of pneumology before be sent in our department, and for that the pachypleuritis is already constituted.

Video-assisted thoracoscopy surgery (VATS)

VATS was initially used in PE in the goal to confirm the diagnosis. After, it was an effective procedure for debridement in the fibrinopurulent PE. Most recently, VATS is described to perform decortication for chronic empyema [Y, X]. VATS has the advantage in postoperative period to decrease chest pain, to allow a fast recovery of the patient and to decrease the duration of the hospital stay. This procedure should be performed under unipulmonary ventilation. According AATS, VATS should be the first line approach in all patients with stage II acute empyema [24].

Decortication by open surgery

Posterolateral thoracotomy remains the main open approach in thoracic surgery. This approach is performed with muscle sparing of the chest wall muscles especially latissimus dorsi that can be useful for obliteration of a residual poche diagnosed in postoperative period of surgery of the PE [7]. After choice of the intercostal space that will be opened and in some cases with rib resection, the surgeon dissects the upper edge of the lower lobe. The extrapleural plan is approached, and the dissection is continued using a finger. During this dissection, the surgeon must be careful up to the subclavian vessels, anteriorly to the interne thoracic pedicle, posteriorly to the descending aorta in the left side and azygous vein in the right side. When the parietal pleura is decorticated, the poche can be opened and the purulent fluid is sucked. The visceral pleura is attacked using the fine scissors. This step is the origin of air leakage in postoperative period because of creation of alveolar lesions that can be sutured. Lung resection is performed according to the quality of underlying lung by the help of the anesthetist. One or two chest tubes are placed in the pleural space according to the surgical procedure how it was unrolled. Generally, an anterior chest tube is placed when the PE take place also in the anterior region of thoracic cavity.

Other surgical procedures

Open window thoracostomy is an invasive pleural drainage procedure consisting in the creation of a window in the chest wall by partial resection of two or three ribs on 8 to 10 cm allowing the access to the pleural cavity in order to perform an effective packing, serial dressing changes, and debridement until we have a sterile cavity. Indication of this procedure remains the failure of other therapeutic options especially closed thoracostomy and decortication. In is indicated also in first line in patients with calcified PE in whom decortication is associated with high rate of morbidity and mortality [21]. In post-pneumonectomy empyema with bronchopleural fistula, open window thoracostomy presents a well option allowing the sterilization of the pleural space.

Thoracoplasty is an invasive surgical procedure that is defined by the removal of a group of ribs in order to obtain the collapse of the chest wall. It has been used for a long time mainly for PE of tuberculous origin. It is currently seldom used because of several disadvantages including progressive scoliosis, chronic pain, progressive pulmonary insufficiency, and a mutilating cosmetic appearance [28].

Muscles plasties or epiplooplasty can be used for obliteration of cavities of a chronic PE or for closure of an associated bronchopleural fistula. Latissimus dorsi conserved during the posterolateral thoracotomy is an important flape in these surgical procedures. Myoplasty can be used after an open window thoracostomy or thoracoplasty.

Conclusion

PE remains a frequent diseases in our country because of endemicity of tuberculosis and hydatidosis diseases. An early appropriate management especially by antibiotics and chest tube drainage allow to decrease the chronic PE that is managed surgically mainly by decortication.

Conflict of Interest

The authors declare that they have no conflict of interest with this manuscript.

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Author Contributions

All the authors contributed substantially to the authorship of this manuscript.

Ethics

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.

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