International Journal of Medical and Health Research
ISSN: 2454-9142
www.medicalsciencejournal.com
Volume 4; Issue 6; June 2018; Page No. 38-43

Comparative evaluation between radiogically guided chest tube drainage vis-a-vis thoracotomy for empyema/loculated pleural effusion

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Abstract
Background: the management of loculated pleural effusion and empyema by chest tube drainage usually fails because of thick viscous fluid and multiple pleural space loculations. The use of radiographic assisted chest tube drainage with intrapleural fibrinolytic agents facilitates pleural drainage and can obviate the need for more invasive surgical interventions in these types of effusions.
Objectives: to evaluate the role of radiographic chest tube drainage with intrapleural fibrinolytic therapy with streptokinase as an adjunctive therapy in the management of loculative pleural effusion and empyema
Material and methods: 40 patients of CPE and empyema were considered for radiographic assisted chest tube drain with adjunctive intrapleural fibrinolytic therapy. Intrapleural, STK was administered 12-24 hourly in the dosage of 2, 50000 IU in 100 ml of saline. The end points were volume of fluid drained and radiological resolution and 40 patients were in the decortication group (control group0
Results: Statistical analysis showed a success of 65% in study group and in thoracotomy group 97.5% with minimal complications in both the groups.
Conclusion: Patients of loculative pleural effusion/ empyema should be first subjected to radiographic assisted chest tube drainage as we have seen from results and then add fibrinolytic if loculations present.

Keywords:chest tube drainage, radiographic

Introduction
Empyema thoracis is defined as pleural space suppurative fluid collection and is a disease entity that has been recognized throughout recorded medical history. The incidence of empyema has fallen since the introduction of antibiotics for the treatment of pulmonary infections. Early diagnosis and effective therapy are essential. The late complications of untreated empyema with a fixed fibrotic chest cavity should only remain in the history books. Pulmonary infections due to iatrogenic causes remain the most important etiology of the loculated pleural effusion/empyema because people now live so long with cardiac failure, rheumatic disorder and breast cancer [1, 2].
Dry pleurisy may be the first indication of pleural Inflammation although this is quickly followed by the outpouring of fluid rich in protein and polymorphs. Although frank purulence should develop before an effusion is referred to as an empyema, a ph<7 is the best marker for the need for operative intervention, and therefore is probably the discriminator for empyema. Continued accumulation of pus compresses the lung with shift of mediastinum to the opposite side. Fibrin is continually deposited on pleural surfaces producing a thickened rind, the deeper layers of which become fibrotic and avascular. The established empyema is walled off and the space is fixed. This allows for open drainage or easy stripping of the empyema membrane (thickened rind) during surgical decortications. Such decortications at this stage will produce full re-expansion of the lung with gradual resolution of the pleural inflammation and no functional impairment. It is this fibrin deposition which limits the diffusion of oxygen that leads to anaerobic respirations and the fall in ph within the empyema.
If the pus is not drained effectively or the empyema cavity excised, the continual formation and fibrosis of the pleural rind progressively restricts chest wall and diaphragmatic movement, eventually producing a shrunken, flattened, immobile hemi-thorax with overlapping ribs and scoliosis to the affected side.
Sometimes empyema may push through the chest wall at one of the perforating pathways of the neurovascular bundle, forming a collar -stud abscess which may break down giving a discharging fistula in continuity with the empyema cavity (empyema necessitans)[3].

Etiology
Despite the availability of antibiotic, 50% of all empyemas currently diagnosed are secondary to complications of a primary pneumonitic process in the lungs. Other causes include spontaneous pneumothorax, chest trauma, sub phrenic abscess, retained foreign bodies in the bronchial tree, esophageal diseases or operations on the esophagus, pulmonary or breast malignancy and surgical procedures involving the lung and mediastinum [3, 4, 5, 6].

Pulmonary infections which include
Pneumonia-(most common)

Lung abscess
Fungal infections
Tuberculosis
Trauma

Chest injuries-including implanted foreign bodies
Post thoracotomy
Ruptured esophagus/leaking anastomosis

Trans-diaphragmatic spread;
Sub phrenic abscess
Hepatic amoebiasis

Iatrogenic; multiple aspirations for effusions

Osteomyelitis- ribs or vertebrae

Septicemia-multiple small lung abscesses
Prior to development of effective antibiotic treatment, pneumococcus and streptococcus was the most frequent causative organism of empyema. Staphylococcus has now emerged as the most frequent causative organism, particularly in children <2years, in whom it is cultured in 92% of patients[3, 7]. Gram negative organisms such as pseudomonas, klebsiella pneumonia, E.coli, Aerobacter aerogenes, Proteus, and Salmonella are the next most common organism. As anaerobic culture techniques improve, these organisms are recognized with increasing frequency.

Pathogenesis
Empyema results from secondary to blockade of pulmonary lymphatics by inflammatory debris or the direct extension of the pneumonic process into the pleural space
The American thoracic society (1962) has classified empyema into three phases based on the natural history of disease:-

1. Exudative or acute phase- characterized by a pleural fluid of low viscosity with a cellular content. During this phase, the lung is still expandable
2. Fibrin purulent or transitional phase- characterized by appearance of more turbid fluid due to an increase in polymorph neutrophils. Fibrin is deposited on both pleural surfaces, forming a limiting peel that prevents extension of empyema but also begins to trap and fix the lung. The pleural fluid becomes increasingly more turbid and the lung progressively less expandable with time.
3. Organizing or chronic phase- characterized by organization of the pleural peel, with ingrowth of capillaries and fibroblasts. The pleural fluid is very viscous, consisting of 75%sediment on standing. The organization can begin as early as 7 to 10 days after the onset of the disease, and usually by 4 to 6 weeks the process has entered the chronic phase [3, 8].

Diagonosis
Diagnosis of loculated pleural effusion/empyema is primarily made on the basis of Clinical features; Imaging, Pleural fluid examination and bronchoscopy.
Clinical features are not specific and Common symptoms include– pleuritic chest pain, Fever, Cough with sputum production, tachypnea, tachycardia, decreased respiratory excursions, and pain on percussion, friction rub and absent breath sounds.
Radiographic examination should include anteroposterior and lateral chest radiographs which demonstrate parenchymal infiltrates or consolidation and pleural space fluid. CT and ultrasonography can delineate the nature and degree of parenchymal disease and character of the pleural fluid or rind when complete pacification of hemi-thorax is noted on plain films.
Bronchoscopy should be done to rule out endobrochial lesions such as tumors, inhaled foreign body or bronchopleural fistula.
In acute stage thoracocentesis sample should reveal, one or more of following features.
ph. <7.2
Glucose<40mg/dl
LDH>1000IU/dl
Protein>2.5
WBC>500/µ
Specific gravity>1.018
Thin serous or cloudy fluid generally sterile [3, 9].
In Fibrin purulent or intermediate stage the fluid becomes thicker, opaque or fluid with positive cultures and in organizing or late stages an organizing peel with entrapment of the lung is seen. A sedimentation fraction of 75 % indicates presence of thick walled empyema and open drainage is safe.

Management
The principals of management have been recognized by Hippocrates and ancient physicians of Greece10 and involved aspiration for diagnosis, repeated aspirations if warranted and tube or open drainage procedures once the cavity was stable.

The Objectives of Therapy Are
Control of local and systemic infection with specific antibiotic therapy.
Evacuation of empyema by one of a variety of methods selected on the basis of the etiology and stage of empyema process.
Re- expansion of the lung with obliteration of the pleural dead space.
Needle thoracocentesis for chemistry analysis and culture is usually the initial diagnostic (and occasionally therapeutic) step coincident with the initiation of intravenous antibiotics. Thin exudates can occasionally be completely evacuated with this maneuver. Thoracocentesis and antibiotics alone have been successful in treatment of empyema in 6 to 20% of patients, particularly with early stage disease.[11, 12, 13, 14] large closed-tube thoracotomy with or without the adjunctive use of fibrinolytic agents has been traditional management with the fibrin purulent stage of the empyema process with reported success rates of 24 to 78%. The organizing phase of empyema requires direct removal of the restrictive coagulum (decortication) with open or laparoscopic technique.

Empyectomy
This refers to a specific manoeuvre - the complete excision of a small empyema without spillage of pus. A previous drainage procedure or the presence of a broncho-pleural fistula precludes this operation. Operative details have been well

described by Dugan and Samson. Dissection is begun in the extra pleural plane and when the edges of the empyema sac are reached, the surgeon 'turns the corner' and then decorticates the inner surface of the empyema from the visceral pleura. Dissection is particularly difficult over the diaphragm where the endothoracic fascia is thin and the extra pleural plane poorly developed [15].

Micro vascular free muscle flaps

There are patients in whom multiple previous operations to deal with a chronic empyema, usually with a broncho-pleural fistula, have failed. Under normal circumstances the use of a muscle flap would be considered but if the local muscles have been divided at previous thoracotomies, these muscles are frequently small and atrophied. In these circumstances Chen *et al*. have used micro vascular free muscle flaps. Contralateral latissimus dorsi and the lower four digitations of serratus anterior are mobilized on the same vascular pedicle, namely the thoracodorsal artery and vein. These muscle flaps are then anastomosed to the remnants of the thoracodorsal artery and vein on the affected side. He states these vessels are easily found. His results in his small series are excellent. The fistula is closed and the empyema space is obliterated. Or unable to cope with a permanent open drain, in which decortication is undesirable or unsuccessful, is the procedure initially described by Clagett and Geracim for management of postpneumonectomy empyema. The same principles may be used for patients with an empyema who have had a limited or no previous pulmonary resection [16, 17, 18].

Thoracoplasty

The purpose of thoracoplasty is to remove the rigidity of the outer chest wall and so establish contact between the now flexible chest wall and either residual lung; or, after pneumonectomy, with the mediastinum in order to obliterate the empyema space. The procedure is rarely undertaken today because of the deformity that results and the success of other forms of management.

Material and methods

This study was conducted in department of CVTS in Sher I Kashmir institute of medical sciences soura. The study was a prospective randomized controlled analysis of all cases of empyema from Sep. 2011 to Oct. 2013. This was a prospective randomized comparative case/ control study, between radiologically assisted chest tube drainage and thoracotomy for loculated pleural effusion/ empyema. Study was comprised of patients treated with radiographic chest tube drainage with the aid of streptokinase and patients treated with open thoracotomy. Both the groups were randomized using randomization table before a particular form of treatment was instituted.

The patients were evaluated in detail. Detailed history was taken from patients (or attendants) and both general physical examination as well as systemic examination was performed. Complete haemogram, serum chemistry, chest radiograph, abdominal ultrasonography and contrast enhanced computed tomography was performed.

Inclusion criteria; patients of all age groups, both sexes, patients giving informal written valid consent for the procedure, patients having radiologically documented loculated pleural effusion/ empyema, patients having supportive / confirmative evidences of empyema from analysis of the thoracocentrically aspirated fluid.

Exclusion criteria; patients not giving valid consent, patients with recent history of septicemia, patients on corticosteroids or immunosuppressents, patients needing surgical intervention for concurrent lung/thoracic lesions., patients having loculative effusion/ empyema at more than two sites

The method used in our study for drainage of loculative pleural effusion/ empyema was a guided approach that is chest tube was inserted under ultrasound guidance and drainage observed for 24-48 hours and radiograph done to look for resolution. If radiograph revealed same findings what was observed before procedure then decision was taken to instill streptokinase. Following streptokinase instillation, drainage and radiographs were monitored for 7-10 days. If improvement did not occur then patient was treated with decortication. 250000 IU of streptokinase was instilled in adults and in children 1500 IU / kg body weight dissolved in 50-100 ml of normal saline was used. Tube was clamped for 2-4 hours. Continuous data was statistically analyzed by using two sample independent t test and paired t test. Data were analyzed by using chi square/ fisher t test. P value <0.05 were considered statistically significant.

Table 1: showing comparison between cases and controls

	Radiographic assisted ICTD Fibrinolytic	Decortication	P- Value
Subjects	40	40	
Length of hospital stay	13.6±2.362	7.9±1.837	<0.0001
Average drainage	1387.5±477.27	703.57±159.48	<0.0001
ICTD removal(in Days)	15.7±1.9	7.9±1.6	<0.001
Pain after procedure	Discomfort related to chest tube	Discomfort related to chest tube and thoracotomy	
Complete radiographic resolution	26	38	
Success	26/40	39/40	
Total cost procedure in rupees	8300±1316.6	610±213.18	<0.0001
Complications associated	Allergy(sometimes fatal), bleeding	Pain, bleeding, air leak	
Hospital turnover	Decreased	Increased	

Discussion

Thoracic empyema still represents a significant cause of morbidity, prolonged hospitalization and mortality up to 10%. Important and common cause of empyema includes pulmonary infection, surgical procedures, trauma, spontaneous pneumothorax, sub diaphragmatic infection and esophageal perforation. Approximately 50% of all bacterial pneumonias develop in pleural effusion, and in 1/3 rd. of these patients the pleural effusion becomes organized, as were have seen in our study that 35% patients did not responded to guide ICTD+ streptokinase. The propensity for developing empyema varies considerably with the type of bacteria producing the common pneumonia, the setting in which the infection is acquired and the alteration in these produce by antibiotic therapy. The second most frequent cause of empyema is post-surgical empyema which accounts for 20% of all cases. In our case series the bacteriological association was found to be insignificant (P- value> 0.10) but tubercle bacilli was found to be a measure etiological agent in 35% of patient population. The clinical picture of thoracic empyema may also be seen with pulmonary embolism, acute pancreatitis, Dressler's syndrome and tuberculosis. The secondary complications of the empyema process include broncho- pleural fistula, empyema necessitans and osteomyelitis of the ribs or spine, invasion of the mediastinum with pulmonary esophageal fistula or pericarditis and brain abscess. In our case series such complication were not observed, suggesting that our interventions were conducted at an earlier stage. Once the diagnosis of empyema thoracis have been made by thoracentesis and approximate gram stain and/ or culture, computed tomographic(CT) scan is used universally to identify underlying parenchymal disease, to distinguish empyema from lung abscesses and to every the presence of loculations, the latter being an important factor in treatment planning. Effective management of empyema requires control of infection by approximate antibiotic therapy, evacuation of pus and obliteration of the empyema activity[18]. In our case series we utilized USG for detection and confirmation of loculations in most of the cases and in few patients the CT scan was utilized [19, 20, 21, 22]. The most important aspect of management is the prompt initiation of effective drainage. Closed chest tube drainage is the usual first step which may take a no. of forms including image guided catheter insertion. Patients frequently come to medical attention when the pleural fluid is not free flowing and closed drainage is unlikely to be successful. The options available to manage inadequate drainage include additional chest tubes, intrapleural fibrinolytics, VATS and thoracotomy decortication [23, 24, 25]. The choice of additional modality drainage depends upon the presence of ongoing pleural sepsis, maturity of empyema, degree of restriction of lung function, familiarity with treatment modalities and debility of patient. Simple drainage via tube thoracostomy as the first procedure has a low success rate and is a predictor of failure of the initial therapy. One option is image guided catheter placement which is safe and highly effective in select patient. Our success rate of 65% with this modality is similar to other authors who have advocated this procedure and this group represents the patients with non- loculated early empyema. However, the added cost of multiple CT scan and the need for multiple catheters in some patients is a potential drawback [26, 27, 28, 29, 30].

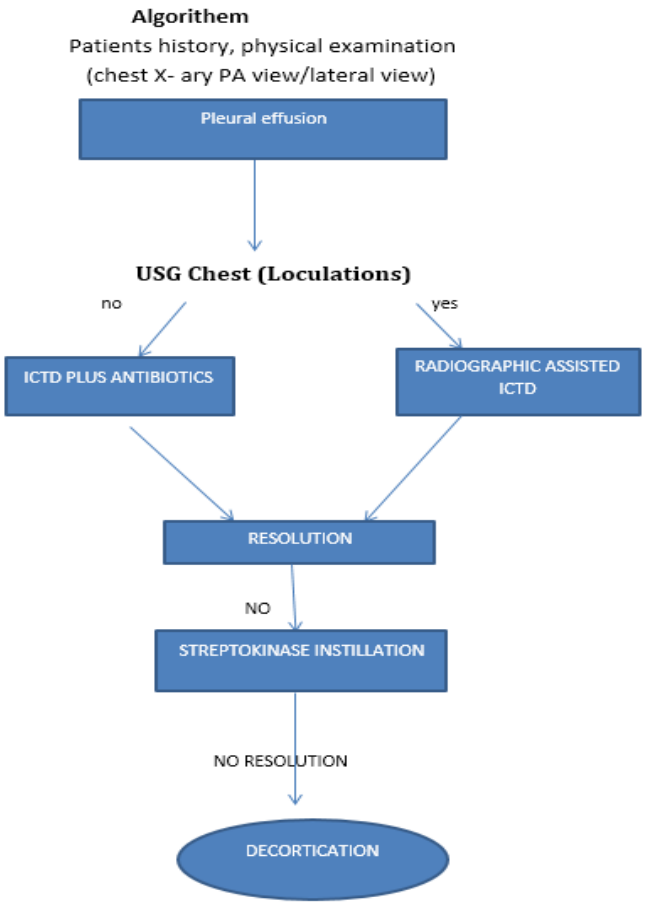
Intrapleural fibrinolytic therapy is another option when there is occlusion of the chest tube with viscous material or there are multiple loculations that fail to drain. Proper staging of the empyema is important when using fibrinolytics since it is less likely to resolve thick walled uniloculated empyema, where the problem is more often incomplete re-expansion of the lung. Based on the available evidences, intrapleural fibrinolytics should not be used for mature empyema but may be considered for early fibrino purulent stage [31, 32]. A Cochrane review of seven randomized controlled trials recruiting 761 patients suggested a potential overall treatment benefit with fibrinolytics but noted that results should be treated with caution as data were incomplete and the benefit was not significant [33, 34, 35, 36]. Although, the no. of patients in our study treated by fibrinolytic therapy was small (35 patients) but the success rate of 65% justifies the use of this modality in early empyema. On the other hand Maskell *et al*. reported that in a double blind trial, 454 patients with pleural infection were randomly assigned to receive either intrapleural streptokinase (250,000 IU twice daily for 3 days) or placebo [37, 38, 39, 40]. They concluded that the intrapleural administration of streptokinase doesn't improve mortality rate of surgery or the length of hospital stay among patients with pleural infection but in our study we observed that rate of surgical intervention was less with radiographic assisted chest tube drainage plus streptokinase, but hospital stay was prolonged (p value< 0.0001).

Surgical approaches, such as open thoracotomy decortication or VATS, are generally reserved for patients with failed conservative treatment, as we have seen in our study that 35% of patients did not respond to radiographic assisted chest tube drainage plus streptokinase. The lack of large, multicenter, randomized, double blinded studies evaluated the role of thoracotomy in the management of empyema make it difficult to define the exact role of this invasive procedure [41, 42, 43]. Most studies of this technique have been reported following the use of VATS. However, regardless of the type of approach the surgical treatment can solve the pleural infection in almost all patients. Decortication in our study had an excellent success rate of 97.5%. Stage of the empyema and patients age is two important determining factors in this regard and the surgical treatment as an initial therapy for advanced empyema and or elderly patients is associated with better outcomes. Open surgery can be performed at any stage of the empyema, but the key point for the effectiveness of the VATS is the early surgical referral and its use in the fibrin purulent phase [36, 37, 40]. Decortication should be considered early in any patient with multiloculated empyema who is a good surgical candidate because it has a highest success rate. Our study results are consistent with international norms. The comparison between the two groups which were selected randomly showed a significant difference of drainage (P value< 0.0001), hospital cost (P value <0.001) and hospital turnover (P value, 0.0001). Postoperative pain (p value 0.45) which was considered earlier one of the phobical issue for both patient as well as the operating surgeon, now a days gets less attention due to recent advances in pain management protocols. Early intervention whether radiographic assisted chest tube drainage with or without streptokinase instillation

or decortication should be entertained. As early we respond to the disease better will be results in terms of cost, morbidity, hospital turnover and success. The results in our study group showed success in 65% of patients with average drainage of 1387.5±477.27 ml over 15.7±1.9 days while as in control group results were 97.5% with average drainage of 703.75± 159.48 ml over 7.9± 1.6 days. The hospital turnover was less with study group as resolution of disease was slow as compared to decortication, which in turn led to increased cost to the hospital as well as to the patient. However the use of radiographic assisted chest tube drainage along with the usage of streptokinase reduces the need for surgical intervention which is a major achievement by less invasive technique.

Conclusion

1. Any patient of loculated pleural effusion/ empyema should be first subjected to radiographic assisted chest tube drainage as we have seen from results that radiographic assisted chest tube drainage has minimal risk of complications and is economical
2. The thrombolytic agents used in Para pneumonic effusions are most effective if administered in the early fibrinopurulent stage.
3. If patient do not respond to guide approach, then streptokinase instillation should be considered.
4. Thoracotomy should be only considered if patient is allergic to streptokinase or patient fails to respond to streptokinase therapy.



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