# An Account of the use of Intrathoracic Flaps in the Management of 12 Consecutive Patients with Residual Cavities following lung surgery

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## ABSTRACT

***Introduction**: Post-operative patients with empyema and residual cavities, with or without bronchopleural fistulae, represent a collection of desperately ill patients whose clinical conditions have challenged surgeons for years. The techniques to manage these complications include three phases which entail total pleural decortication, obliteration of the empyema cavity, and coverage of the raw parenchymal surface with viable tissue. These, together with proper and effective pleural drainage, have evolved with time and continue to undergo modification. **Patient and methods:** Twelve patients have been divided into two groups according to the presence or absence of bronchopleural fistula and treated with various intra-thoracic flaps. **Results:** Results revealed sound healing in ten patients out of twelve. Two patients showed complete failure with persistent bronchopleural fistula and empyema. **Conclusion:** Intra-thoracic flaps could be used for obliteration of residual postoperative cavities, with or without associated bronchopleural fistulae. In our study, various muscle flaps or omental flap offered enough tissue to obliterate and reinforce healing of vulnerable bronchial stumps after pulmonary resections.*

***Key words**: intra-thoracic flaps, empyema, dead space obliteration, bronchopleural fistula.*

## INTRODUCTION

In the thoracic surgical literature, many studies have shown that patients with immunosuppressive disorders, including those resulting from chronic use of corticosteroid and preoperative chemotherapy, have a higher tendency to develop bronchopleural fistulae (BPFs) and empyema after pulmonary resection. Additional risk factors include malnutrition, and underlying parenchymal lung diseases, such as severe chronic obstructive pulmonary disease. [1-3]

Causes could also be classified to pre, intra and postoperative. Preoperative risk factors include age more than 70 years, COPD with $FEV_1$ <0.8 L/min., malnutrition, steroid therapy, previous infection or chemo/radiation therapy. Intraoperative factors include right pneumonectomy, higher-stage tumors, extended nodal dissection, unhealthy bronchus, long bronchial stump, contamination of pleural space during procedure. Postoperative factors as in cases requiring mechanical ventilation.[4]

Chronic primary empyema is a very challenging complication of an inadequately treated para-pneumonic effusion. It might also be a sequel of pleural instrumentation, or surgery for a different parenchymal or pleural disease. The classic treatment for such a complication, and for the associated underlying BPF, is total pleural decortication, with elimination of the empyema cavity, then the use of viable supple tissue to cover the exposed raw surface of the parenchyma, together with draining the pleural cavity, in a wide effective manner.

Another method may be used in selected cases with overwhelming infection and no fear of lung collapse (peripheral lung adherent or post pneumenctomy) as alternative to closed chest tube system is the Eloesser flap method of open pleural drainage which is limited resection of one or two ribs in the most dependent part of the pleural cavity with suturing of the skin edges to the underlying pleura. This procedure was described by Robinson in 1916 [5] and later by Eloesser in 1935[6], leaving open the entire thoracotomy which may allow for more thorough debridement of all recesses of the pleural space and detection of occult fistulae.

Intra thoracic muscle transposition is not new. In 1911, Abrashanoff reported the successful use of muscle tissue for closure of bronchopleural fistulae[7].Five years later, Robinson reported open pleural drainage combined with transposition of the latissimus dorsi muscle to successfully obliterate a chronic nontuberculous empyema cavity[5]. It was not until 1938, however, that Gray reported the use of a smaller thoracotomy window through which muscle flaps could be passed when transposing them into the chest[8].Since then, just minor refinements have been introduced to intrathoracic muscle transposition, still all were based on the basic concept of the transposition of autogenous viable tissue to the chest.

Although bronchopleural fistula (BPF) and empyema are infrequent complications following pulmonary resections, yet they are quite serious. The incidence of BPF following pulmonary resections was reported to be 1.5% to 28%, and has been linked to the etiology of the condition, the used surgical technique and the surgeon's experience. As for empyema, its incidence following pulmonary resections was reported to be 2% to 16%. Lung resections in an anatomic pattern, e.g. lobectomy or pneumonectomy, performed in cases of inflammatory/infectious conditions were found to predispose to these complications postoperatively.[1-3, 9]

Postoperative empyema and BPF have high morbidity/mortality rates that have classically justified the utilization of extrathoracic muscle flaps to eliminate dead-space and cover bronchial stumps. [10, 11]

Intra-thoracic muscle flaps could be used in thoracic surgery patients who have undergone lobectomy, pneumonectomy, or decortication procedures with established cases with empyema, dead space with or without bronchopleural fistulae. [12-15]

## PATIENTS AND METHODS

Twelve patients were operated upon From January 2015 through January 2017 in Kasr Alaini hospital, faculty of medicine, Cairo University. Patients were divided into two main groups: Group (A) consisting of seven cases with persistent air leak with bronchopleural fistula and primary or recurrent empyema with residual cavity.

Group (B) consisting of five cases with residual cavity with no air leak (no bronchopleural fistula).

They had previously undergone posterolateral thoracotomies at Kasralainy hospital whether for anatomic resection of an inflammatory or neoplastic etiology or for decortication for chronic empyema.

*Operative Procedure*

The thorax was entered through a previous standard posterolateral thoracotomy scar (usually the fifth intercostal space). The plastic team started first, elevating the skin flap, trying to spare as much as possible of the latissmus dorsi muscle, which was in most patients cut transversely at the fifth space to a variable length. The intrathoracic disorder was repaired before consideration of muscle transposition. Thus any fistula of the airway was closed as a first step; next, muscle flap was transposed to support that direct closure.

In Group (A): in two patients the bronchopleural fistulae could not be closed directly due to friable tissue and fibrosis of the remnant stumps. In these latter situations, muscle was inserted at the open fistula and sutured to its edge. While five patients with bronchopleural fistulae were closed directly using prolene3/0 on rounded body needle.

In Group (B) patients, muscle and/or omentum was also used to obliterate minor residual pleural spaces.

A specific muscle, and/or omentum, was chosen depending on the site the location of the residual intrathoracic defect. In lower (more caudal) cavities, omentum was used to obliterate the defect. In higher level (more cranial) cavities, LD muscle was used if available, after passage through a small window created posteriorly to pass the flap. Other factors were also considered such as the axis and arc of the selected muscle, potential loss of function and external deformity that could result from use of the selected muscle and the extent of damage to the latissimus dorsi muscle during previous thoracotomy.

The muscle was generally elevated on its dominant proximal blood supply. A 7 to 10cm segment of rib (usually the second and third) was resected near the axis of the muscle, which was in the posterior axillary line for the latissimus dorsi, the mid axillary line for the serratus anterior, and at the mid clavicular level for the pectoralis major. The omentum entered the chest via the diaphragm. The muscle was then sutured directly to the repaired intrathoracic structure. If necessary, debridement was also accomplished before obliteration of the cavity. An intercostal tube was then inserted between the chest wall and the flap for drainage of both air and fluid. It was removed after stoppage of air leak and fluid became serous with a volume of about 50cc in the underwater seal also guided by a follow-up CT chest. A subcutaneous suction drain was also inserted. In apical cavities, latissimus, serratus or pectoralis flaps were used. While in basal cavities, omentum was used allowing for better reach of the cavity space.

In the serratus muscle flap, only the upper four digitations were used to avoid winging of the scapula. In some cases of the latissimus muscle flap despite it was cut through during the previous thoracotomy incision; however its distal portion could also be elevated with its proximal part and utilized if elevated as an extended latissimus myocutaneous flap after deepithelialization of its skin island. May be its blood supply coming to the distal part through the subdermal and subcutaneous plexuses of the deepethelialized skin island thus allowing for better reach of the latissimus flap to the more distal cavity. Also this deepethelialized skin island makes this flap more bulky helping to obliterate the dead space.

## RESULTS

Table1 shows the operative indications, procedure, results of the 12 patients. The operations were performed electively. In Group (B), Five patients had chronic empyema alone, after lung surgery whether resection or decortication without bronchopleural fistula. Patients underwent total pleural decortication and abolition of the empyema cavity with use of various flaps. Among Group (A), two had previously undergone ipsilateral thoracotomy or thoracoscopy for bullae resection and had developed a loculated empyema cavity with an air–fluid level that hinted occult underlying BPF. Two patients underwent upper lobectomy for caseating localized *Mycobacterium* tuberculosis complicated by secondary bacterial empyema and bronchopleural fistula. Three patients with neoplastic lesions for which anatomic resection was done, complicated postoperative by empyema and occult bronchopleural fistula. These patients underwent total pleural decortication and obliteration of the empyema cavity with buttressed closure of the underlying BPF with use of various flaps.

The mean estimated blood loss was about500 cc. Seven patients did not require intraoperative blood transfusion; Five patients required transfusion of 2 units of packed red blood cells in average per patient. There were no grave intraoperative complications and no operative deaths. Two patients had failed surgery and persistent empyema with bronchopleural fistula.

**Table (1): Patients Undergoing Intra-thoracic flaps Transposition**

| | Sex/age | Indications | procedure | complications | result |
|---|---|---|---|---|---|
| **1** | Male/25 | Post lobectomy Bronchopleural fistula and empyema | Serratus anterior muscle flap | Mild scapula winging | good |
| **2** | Male/45 | Post pnemonectomy Bronchopleural fistulae and empyema | Latissimus muscle flap +pectoralis muscle flap+omental flap | Wound infection Persistent Bronchopleural fistula +empyema | failure |
| **3** | Male/37 | Post Bullectomy Bronchopleural fistula and empyema | Latissimus muscle flap | seroma | good |
| **4** | Male/37 | Post pneumonectomy Bronchopleural fistula and empyema | Latissimus muscle flap | seroma | good |
| **5** | Female/44 | Post Lobectomy Bronchopleural fistula and empyema | Latissimus muscle flap | none | good |
| **6** | Male/61 | Post pneumonectomy Bronchopleural fistula and empyema | Latissimus muscle flap | Persistant Bronchopleural fistula | failure |
| **7** | Male/37 | Post Bullectomy Bronchopleural fistula and empyema | Latissimus muscle flap | seroma | good |
| **8** | Male/29 | Post Decortication empyema | Serratus muscle flap | none | good |
| **9** | Male/53 | Post Decortication empyema | Serratus muscle flap | Wound infection | good |
| **10** | Male/55 | Post Decortication empyema | Latissimus muscle flap | none | good |
| **11** | Male/56 | Post Lobectomy empyema | Latissimus muscle flap | none | good |
| **12** | Male/59 | Post Lobectomy empyema | Pectoralis muscle flap | none | good |

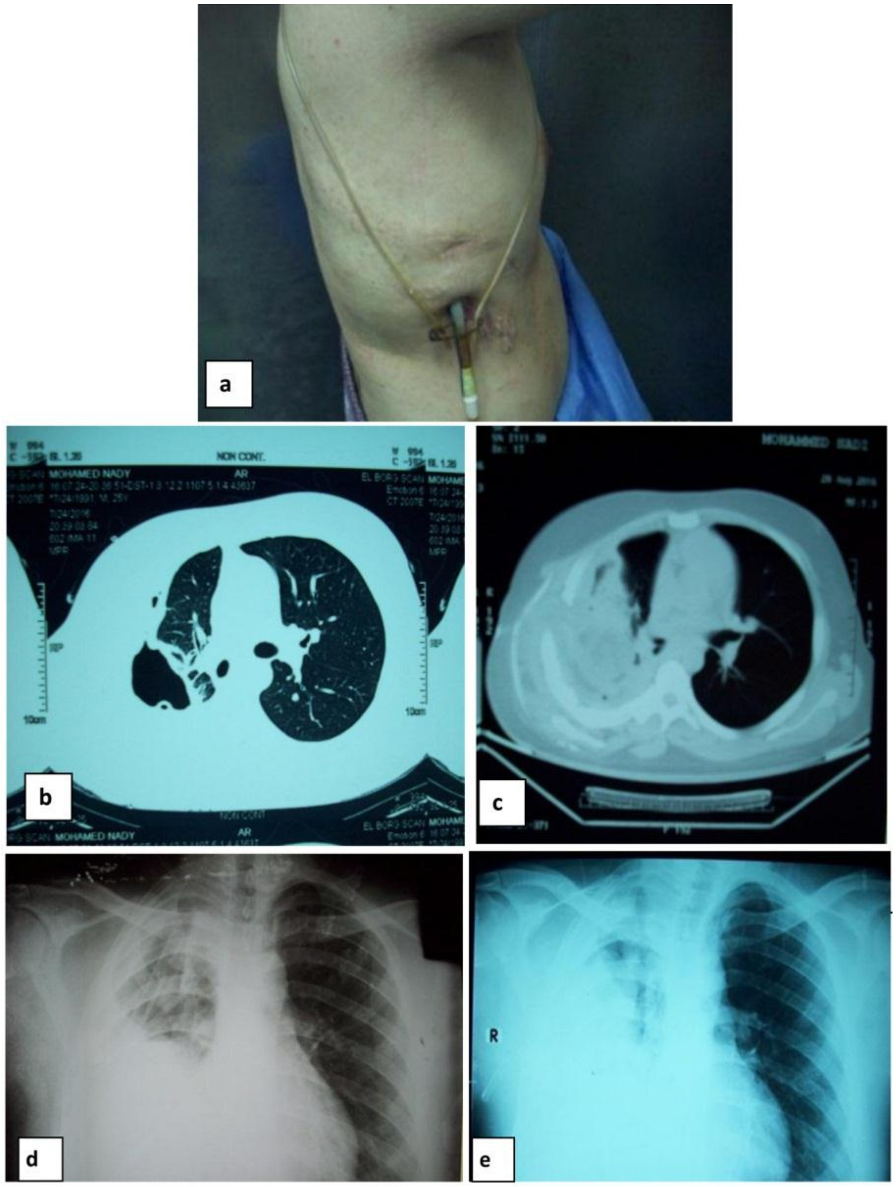


**Figure (1):** Post lobectomy patient with empyema &bronchopleural fistula treated with serratus ant. muscle flap: (a) Preoperative, (b) CT chest (axial view) showing empyema cavity (c) Intrathoracic muscle obliterating dead space and fistula, (d) Preoperative chest radiograph, (e) Postoperative showing a shadow at the right apex representing the transposed serratus muscle partially filling the cavity.

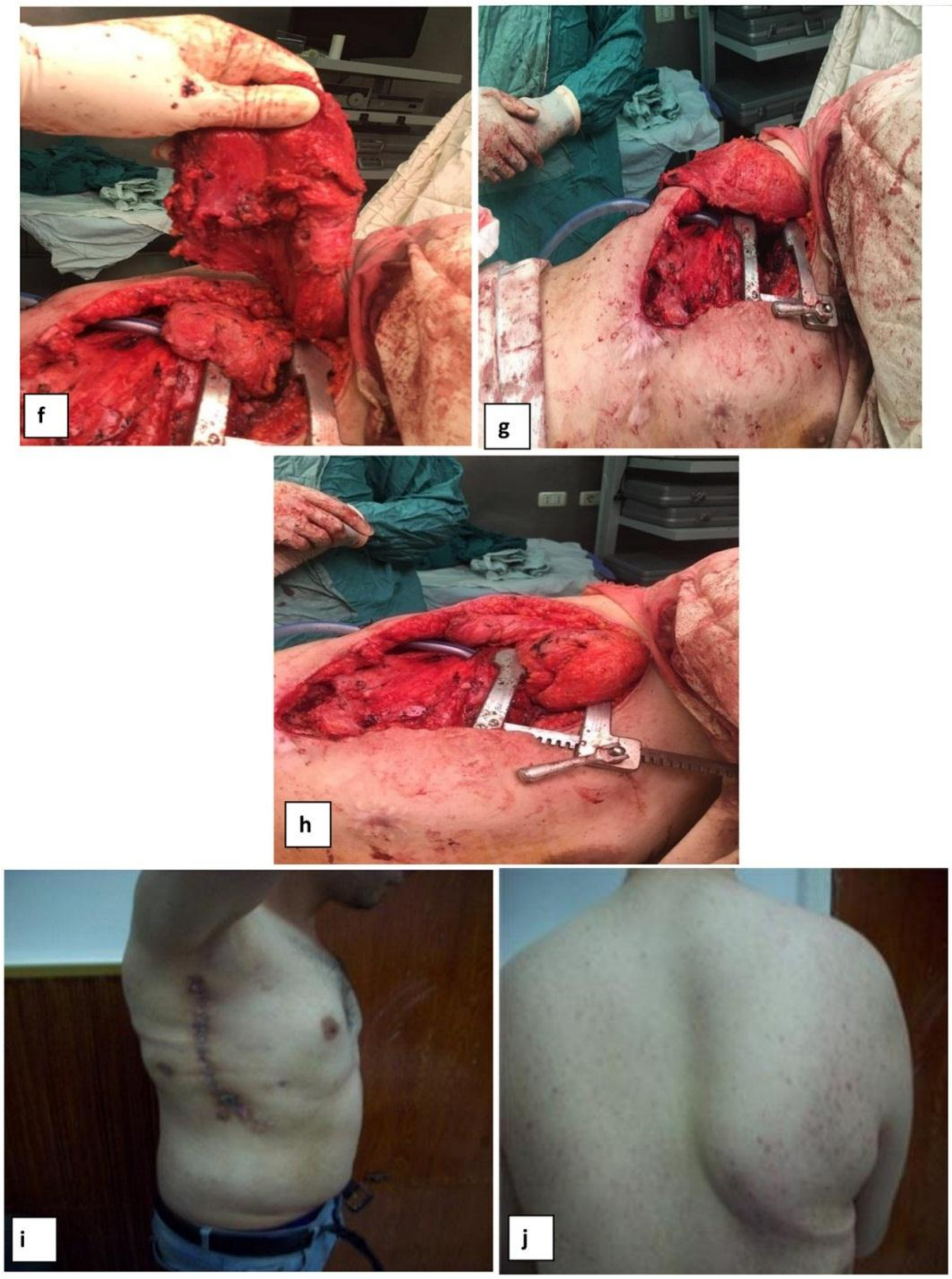


**Figure (1) cont.:** (f) Intraoperative picture showing elevated serratus ant. muscle flap, (g) Resected third rib, (h) Intrathoracic muscle transposition, (i) Postoperative photo, (j) Winging of the right scapula.

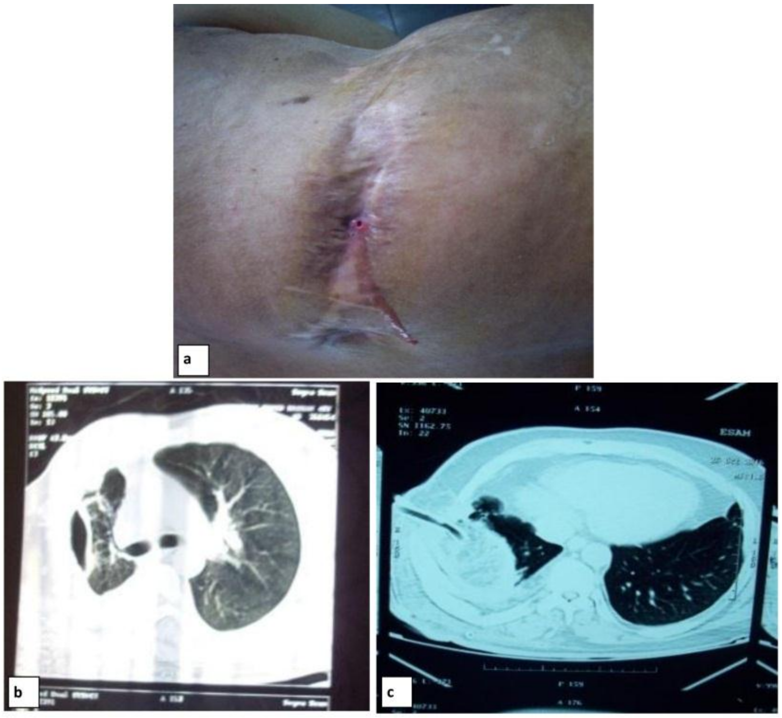


**Figure (2):** Patient with recurrent TB empyema cavity and bronchopleural fistula (3 previous operations): (a) Fistula on back with infected discharge and froth, (b) CT chest showing calcified wall of empyema cavity, (c) Intrathoracic muscle transposition.

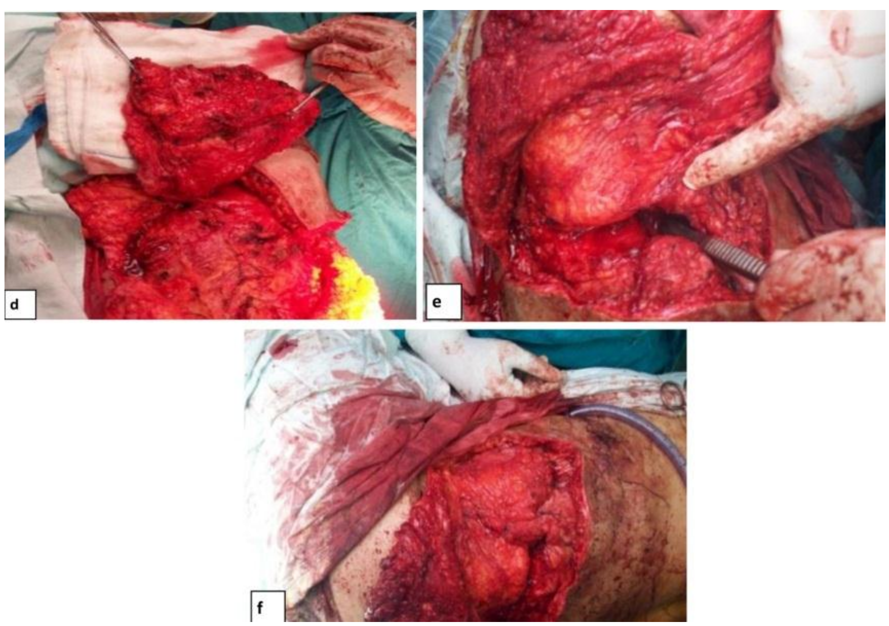


**Figure (2) cont.:** (d) Intraoperative picture showing extended latismussdorsi flap, (e) Empyema cavity, (f) Intrathoracic muscle transposition.

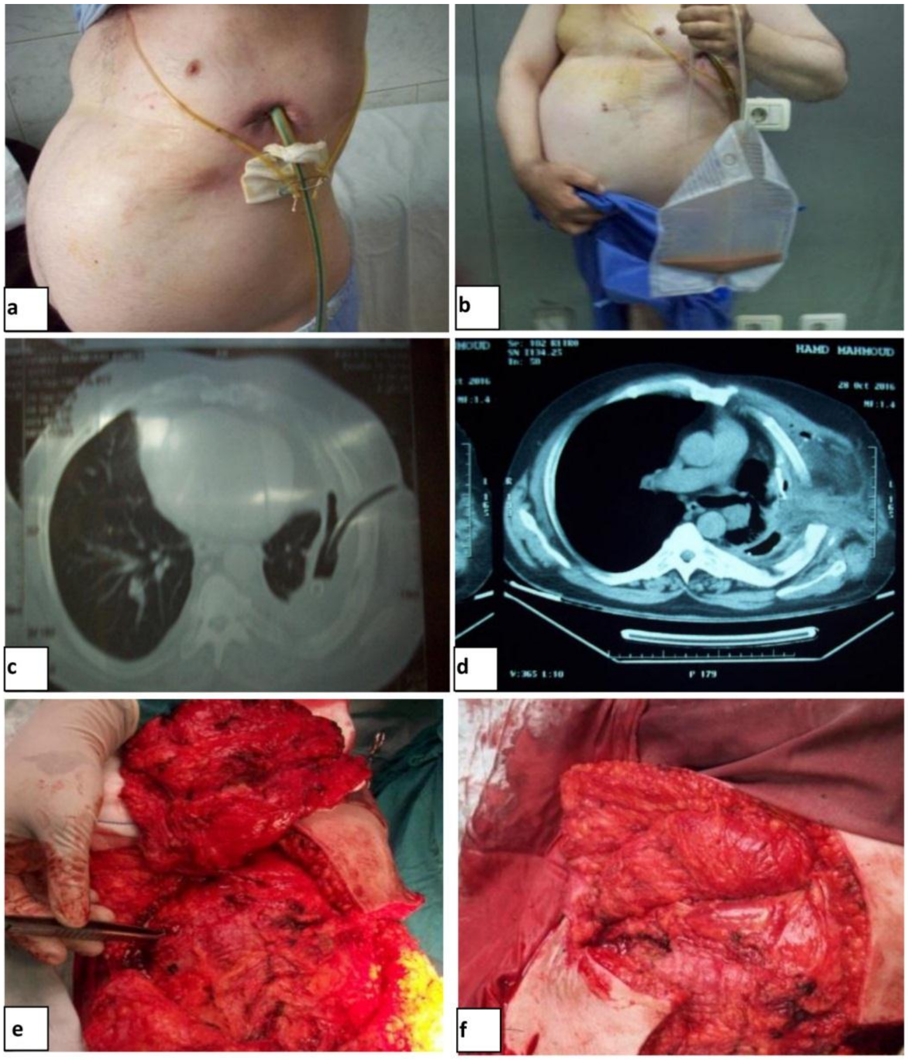


**Figure (3):** A patient with post lobectomy empyema with no bronchopleural fistula: (a& b) Preoperative pictures showing infected discharge,(c) CT chest (axial view) showing calcified wall of empyema cavity, (d)Intrathoracic transposed muscle in place, (e) Intraoperative pictures showing latissimusdorsi flap, (f)Intrathoracic muscle transposition.

## DISCUSSION

Abrashanoff in 1911 first described the use of intrathoracic muscle transposition for the surgical management of BPF[7]. Since then many surgeons have utilized extrathoracic muscle flaps to treat tough pleural space infections, and to re-enforce the repair of bronchopleural fistulae. The chest-wall skeletal muscles, including the latissimus dorsi, pectoralis major, and serratus anterior muscles, have been transposed most frequently[16-19] also the rectus abdominis muscle and pedicled omentum have also been used [20-23]. The prophylactic use of an extrathoracic muscle to prevent postoperative BPF has rarely been practiced.

In elective surgery, especially in low-risk patients, the use of an intercostal muscle flap to cover the bronchial stump after lobectomy/pneumonectomy is a viable option, and maybe preferred, due to its ease of harvest, without any additional incisions. The local intercostal muscle flap is most commonly used in the elective prophylactic coverage of high-risk bronchial stumps [13-15]. However, the intercostal muscle bulk is insufficient to obliterate the usually fibrotic and infected resection bed. Therefore, in such situations, the use of extrathoracic muscles would be preferred [11, 24].

Clearly intrathoracic muscle transposition is the pivotal point that determines success. In the past, recurrence of these conditions frequently followed dehiscence of the repair. Well-vascularized striated skeletal muscle prevents dehiscence and is an excellent tissue to transpose into the thorax. The experience in recent years has amply demonstrated that muscle behaves very favorably when placed in contaminated wounds. Not only will muscle seal a dehiscent repair, but muscle will also obliterate small residual pleural space and may potentially increase antibiotic levels to an isolated pleural cavity.[25-28]

The serratus anterior, latissimus dorsi, and pectoralis major muscles are used in most of intrathoracic transpositions. All three muscles have a large, dominant blood supply that is the axis of the muscle flap. The muscles are generally transposed by dividing all of their chest wall attachments. The latissimus dorsi and the pectoralis major muscles result in little cosmetic or functional defect. We emphasize that muscles, in general, are transposed into the chest to reinforce closure of leaks and that the primary goal of the muscle is to prevent recurrence of the fistula and not only to obliterate pleural dead space.[29]

However if a residual pleural space is small (less than 300 cc), a secondary benefit of the muscle is obliteration of this space. We believe that when confronted with a life-threatening intrathoracic infection, muscle flaps present an excellent opportunity to salvage a number of otherwise hopeless patients. When basic general surgical and wound healing principles are followed, intrathoracic muscle transposition can control these potentially tragic situations in approximately 75% of the patients.[10, 30]

Several considerations guide the decision to use a particular muscle flap for intrathoracic transposition: the surgeon's accurate knowledge of the vascular perfusion pattern of each muscle. Moreover, the efficiency of the considered pedicled flap as in offering sufficient length to reach the targeted intrapleural location and sufficient bulk successfully obliterating the infected pleural space. Thus, if the cavity is mainly apical, the latissimus, pectoralis or serratus could be used. However, if the cavity is mainly basal then omental or rectus abdominis is preferred. In some cases, both apical and basal flaps are used with large residual cavities and recurrent cases. Moreover, if extrathoracic muscles are being selected as flaps, the surgeon should take into consideration the donor site morbidity. Some muscles are less dispensable than others that their sacrifice may lead to substantial functional deficit or contour irregularity. [20, 29]

The latissimus dorsi muscle may be utilized without a grave effect on the patient's shoulder/arm movement. In our study, the latissimus muscle flap could be taken as an extended flap which includes elevating the distal transected part of the muscle (from previous thoracotomy after checking it has adequate blood supply) with its proximal part . This could be done by elevating it with a deepethelialized overlying Skin Island. This skin island acts as a conduit for allowing perfusion of the distal transected segment of the muscle. It also acts to increase bulk of the flap helping to obliterate the empyema cavity.[23]

On the other hand, the pectoralis major and serratus anterior muscles are not utterly expendable, and their harvest for use as flaps may lead to functional disability or physical deformity. Sacrifice of the serratus anterior results in some winging of the scapula. To minimize this complication, careful dissection of the serratus anterior is done to preserve intact the top two - three slips of muscle whenever possible. One of our patients had mild winging of the scapula that the patient was aggravated by. Nonetheless we believe that in the majority of patients the scapular winging is a reasonable tradeoff for the gain that can be achieved in control of thoracic infection. One additional consideration regarding the serratus anterior muscle is that a previous standard postero-lateral thoracotomy rarely divides more than just the lower one fifth of the muscle, leaving the majority of the muscle intact for subsequent transposition.[27]

Harvesting the pectoralis major for use as a transposition flap may have a functional impact, and will result in the loss of the anterior axillary fold leading to a considerably deformed contour of the chest wall.[19]

Rectus abdominis muscle flap and omental flap are usually the last resort flaps to be elected for intrathoracic transposition. There is some additional morbidity involved during harvesting these flaps: a separate abdominal wound, and for an omental flap entry into the peritoneal cavity which possible risks of blood loss, infection, or visceral injury. Finally, the sacrifice of the rectus abdominis weakens the anterior abdominal wall and may result in hernia formation especially in a thin malnourished individual.[16, 20, 21]

## CONCLUSION

Intrathoracic flaps could be used for obliteration of postoperative cavities with or without associated bronchopleural fistulae. The use of most extrathoracic muscle flaps will not gravely weaken the shoulder/arm function or cause serious deformity. We recommend the use of muscle or omental flaps to reinforce the closure of open bronchial stumps and/or obliterate large intrathoracic cavities following pulmonary surgical resections. We believe that such flaps may solve the challenging complications of those seriously ill chronic patients, and may reduce the likelihood of their recurrence.

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