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## Surgical chest complications after liver transplantation

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### Abstract

Liver transplantation is a major abdominal operation and the intimate anatomic relation of the liver with the right hemidiaphragm predisposes the patient to various manifestations in the chest cavity. Furthermore, chronic liver disease affects pulmonary function before and after liver transplantation resulting in a considerable percentage of patients presenting with morbidity related to chest complications. This review aims to identify the potential chest complications of surgical interest during or after liver transplantation. Complications of surgical interest are defined as those conditions that necessitate an invasive procedure (such as thoracocentesis or a chest tube placement) in the chest or a surgical intervention performed by a thoracic surgeon. These complications will be classified as perioperative and postoperative; the latter will be categorized as early and late. Although thoracocentesis or a chest tube placement is usually sufficient when invasive measures are deemed necessary, in some patients, thoracic surgical interventions are warranted. A high index of suspicion is needed to recognize and treat these conditions promptly. A close collaboration between abdominal surgeons, intensive care unit physicians and thoracic surgeons is of paramount importance.

**Key Words:** Surgical chest complications; Liver transplantation; Chest related morbidity; Multidisciplinary treatment; Surgery

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**Core Tip:** Chest complications during and after liver transplantation significantly affects the surgical and hospitalization outcomes. This minireview focuses on surgical chest complications for transplant patients and categorizes them by time of appearance. This paper may be a helpful guide and tool for medical students, members of the transplantation team and all the collaborative specialties to recognize early chest complications and plan the appropriate treatment.

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## INTRODUCTION

The diaphragm is the boundary between the thoracic and abdominal cavities. Yet, it is common in everyday clinical practice to observe pathologies that originate in one cavity impacting the other[1]. Liver transplantation is a major abdominal operation and the proximity of the operating field with the right hemidiaphragm predisposes it to various manifestations in the chest cavity. Furthermore, chronic liver disease affects pulmonary function before and after liver transplantation resulting in a considerable percentage of patients presenting with morbidity related to chest complications. Age, model for end stage liver disease (MELD) score, preexisting lung disorders and perioperative events, particularly transfusion, contribute to these complications[2]. Indeed, pulmonary complications constitute a significant problem after liver transplantation[3-5]. In one retrospective study enrolling 135 patients, the first postoperative chest roentgenogram was within normal limits in less than half of the cases[6]. In another cohort of adult-to-adult living donor liver transplantation, chest complications were observed in 19.8% of recipients[7]. In the retrospective study by Panfili *et al*[8], pulmonary complications were frequently revealed on imaging during the first postoperative week.

This review aims to identify the potential chest complications of surgical interest during or after liver transplantation. Complications of surgical interest are defined as those conditions that necessitate an invasive procedure (such as thoracocentesis or a chest tube placement) in the chest or a surgical intervention performed by a thoracic surgeon. These complications will be classified as perioperative and postoperative; the latter will be categorized as early and late.

## PERIOPERATIVE COMPLICATIONS

Intraoperative pneumothorax is a well described complication of surgery with liver transplantation not being an exception and should be promptly recognized and treated as it can result in life-threatening tension pneumothorax. Pneumothorax can occur because of a bleb rupture, a tracheobronchial trauma during orotracheal intubation, an accidental lung puncture during central venous catheter placement or diaphragm perforation during dissection and barotrauma. Bozbas *et al*[9] described another mechanism during liver transplantation. After the extraction of a voluminous native liver, the rapid expansion of the right lower lobe resulted in a massive air leak, probably due to the development of important shear forces that damaged the pulmonary parenchyma. The insertion of a chest tube is the first therapeutic measure, while persistent air leaks or tracheobronchial lacerations should be treated accordingly.

## POSTOPERATIVE COMPLICATIONS

### **Early postoperative complications**

The most typical early postoperative complication is pleural effusion with an estimated incidence of 32%-47%[9-11]. It occurs more frequently on the right side, with left-sided occurrence being rare. Its pathogenesis is multifactorial. Ritschl *et al*[12] identified the following mechanisms responsible for the occurrence of pleural effusion: (1) Low serum albumin levels and postoperative hypoproteinemia; (2) High rates of intraoperative blood and fluid transfusions; and (3) Local mechanisms at the right side of the diaphragm. More specifically, the diaphragmatic defects allow fluid migration towards the chest cavity. Moreover, right hemi diaphragmatic paralysis caused by perioperative right phrenic nerve injury results in the right lower lobe atelectasis, favoring the development of pleural effusion.

There is no consensus concerning indications for chest tube placement and the choice of treatment modality depends mostly on clinical experience and individual appreciation. Similarly, there is no recommendation concerning the type and size of the chest tube. Chest tube placement is necessary for

22%-52% of liver recipients. In a large retrospective study analyzing 597 liver recipients, 12 patients with effusion were treated by a chest tube and had a higher MELD score. Other significant risk factors are recipient body mass index (BMI), hospitalization status before liver transplantation [home, hospital, intensive care unit (ICU)], number of intraoperative red blood cell transfusions and donor BMI[5]. There are emerging recommendations advocating for preventive right chest tube placement in the early postoperative period since a decrease in infectious pulmonary complications and ICU stay has been observed[12]. However, the potential complications of invasive percutaneous pleural procedures (thoracentesis and chest tube placement) should also be considered. The more frequent complications are pneumothorax due to accidental lung puncture and hemothorax due to coagulopathy or technical pitfalls causing minor (pleural) or significant (vascular injury most of the time involving an intercostal artery) hemorrhage. In a large retrospective multicentric study, the incidence of hemothorax was 0.42%, and it was more frequent among patients who underwent thoracentesis[13]. Nearly half of these patients underwent thoracic surgery (thoracotomy or thoracoscopy). This condition was associated with a high (50%) mortality rate. Postoperative hemothorax can also occur after central venous catheter introduction, especially in patients with coagulopathy[13]. Diaphragmatic lacerations or resection during liver transplantation can also result in postoperative hemothorax. The mispositioning of the chest tube (in the subcutaneous tissues or a subdiaphragmatic location) must also be cited. Another complication is re-expansion pulmonary edema, which occurs during the rapid evacuation of massive pleural effusions[14].

Bacterial pneumonia is a common postoperative complication in liver recipients. In the retrospective study of Ma *et al*[15], one-third of patients enrolled developed bacterial pneumonia[15]. This group of patients had an extended hospital stay and more frequent pleural effusions than patients without pneumonia. Without prompt treatment, a parapneumonic pleural effusion can evolve into a pleural empyema, a significant source of morbimortality[16].

### **Mid-term and chronic postoperative complications**

Liver recipients are prone to opportunistic infections because of immunosuppression. Some conditions may affect the lung and cause lung necrosis and cavitation[17]. Consequently, air leaks may result in pneumothorax, pneumomediastinum and subcutaneous emphysema[18,19]. A common pathogen is *Pneumocystis jirovecii*, and treatment is no different than in the general population; watchful waiting, chest tube placement or exploratory thoracoscopy. *Pneumocystis* pneumonia is a relatively late complication after liver transplantation; however, it can occur at an earlier setting (within 1 to 3 wk postoperatively). Its incidence is very low (inferior to 1% during the 1<sup>st</sup> year) in patients receiving prophylaxis, while it is estimated to be between 3% and 11% in the absence of prevention[19,20].

Invasive aspergillosis is the second most common fungal infection after liver transplantation and is associated with high mortality rates[21,22]. A high clinical suspicion is warranted, especially in the early postoperative period. A computed tomography scan is beneficial in identifying the characteristic lesions caused by invasive aspergillosis. Antifungal drugs are the mainstay of treatment, but lung resection can be curative in selected cases as in the case reported by Abe *et al*[23].

The diaphragm itself can be injured during liver transplantation and result in substantial morbidity, as in the case reported by Rosat *et al*[24]. Their patient experienced a left diaphragmatic herniation 5 years after orthotopic liver transplantation. This complication is more common in pediatric patients but rare in adult patients. A traumatic dissection and the excessive use of cautery during liver transplantation are factors responsible for the devitalization of the diaphragmatic muscle. The immunosuppression hinders the healing process. The negative intrathoracic pressure combined with the positive intraabdominal pressure results in the defect's enlargement and the migration of the abdominal viscera into the thorax. The clinical spectrum may vary from totally asymptomatic patients or the presence of non-specific digestive symptomatology to life-threatening visceral strangulation. Once a diaphragmatic hernia is detected, elective repair is warranted, and the abdominal approach is privileged over the thoracic, although there is still debate concerning optimal surgical access.

Chronic pleural effusions constitute a significant source of morbidity among liver recipients. A thick visceral fibrous peel develops if a pleural effusion is untreated, resulting in a trapped lung and restrictive respiratory syndrome. Cuk *et al*[25] provides an overview of this entity. In their retrospective study, the incidence of the trapped lung in patients with persistent pleural effusion was 21.4%. These patients present increased mortality, extended hospital stay and more surgical interventions in the chest. In this cohort, nearly all pleural effusions were exudates, which support the hypothesis that a chronic inflammatory process occurs in the pleural cavity resulting in the migration of fibroblasts and the development of the pleural peel. Parapneumonic pleural effusions, especially pleural empyema, are a major cause of trapped lung occurrence. Intraabdominal sepsis is a predisposing factor for developing pleural empyema[1]. A frequent pitfall while treating these patients is the false diagnosis of pneumothorax after a thoracentesis for pleural effusion. It is instead a suboptimal lung expansion rather than a true pneumothorax. Sometimes the thickened visceral pleura is visualized in the chest roentgenogram and the correct diagnosis can be established, avoiding thus unnecessary additional pleural interventions such as chest tube placement and elevated suction levels that can result in a lung tear. Shirali *et al*[16] analyzed the outcomes of 33 liver recipients with pleural space complications who necessitated a thoracic surgical intervention due to chronic pleural effusion and empyema. The most common thoracic

**Table 1** List of complications and prevention measures

Timing of complication	Type of complication	Prevention measures
Intraoperative	Pneumothorax	High level of suspicion Cautious OT intubation CVC placement under echography guidance Low airway pressures during mechanic ventilation Closure of diaphragmatic defects encountered during LTx
Early postoperative	Pleural effusion	Correction of hypoproteinemia Limited perioperative blood transfusions Proper surgical technique Preventive chest tube placement
		Echographic guidance for percutaneous pleural procedures
		Correction of coagulopathy
		Echographic guidance for percutaneous pleural procedures
	Pneumothorax	Proper surgical technique during LTx
		Pain management
		Chest physiotherapy
		Drainage of pleural effusions
	Hemothorax	Proper surgical technique
		Staged evacuation of massive pleural effusions
		Chest physiotherapy
		Early extubation and weaning from mechanical ventilation
	Atelectasis	Prevention and treatment of atelectasis
		Drainage of parapneumonic pleural effusions
Mid-term and chronic	Opportunistic infections causing lung necrosis and cavitation	Proper prophylaxis
		High clinical suspicion
	Invasive aspergillosis	Prompt imaging (CT scan)
		Proper surgical technique during LTx
	Diaphragmatic herniation	Prompt treatment of pleural effusion before chronicity
		Radical treatment of pleural empyema

CT: Computed tomography; CVC: Central venous catheter; LTx: Liver transplantation; OT: Orotracheal.

operations were decortication and empyema evacuation. The 30-d morbidity was 69.7%. The authors concluded that developing pleural space complications requiring surgery in orthotopic liver transplant recipients suggests a poor prognosis.

## CONCLUSION

Surgical chest complications following liver transplantation are prevalent and constitute a significant source of morbidity and mortality (Table 1). Most of these complications in liver recipients do not differ from the formal population, whilst others are specific to the transplanted patients primarily because of the immunosuppression. A thoracocentesis or a chest tube placement is usually sufficient when invasive measures are deemed necessary. Nevertheless, in some patients, thoracic surgical interventions are warranted. A high index of suspicion is necessary to recognize and treat these conditions promptly. A close collaboration between abdominal surgeons, ICU physicians and thoracic surgeons is of paramount importance.

## FOOTNOTES

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