



# Incarceration of a diaphragmatic hernia complicated by a tension fecopneumothorax after left hemihepatectomy: Review of the literature and case report

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## Abstract

Incarceration of abdominal organs in a diaphragmatic hernia is a potentially life-threatening condition. It is associated with significant morbidity and mortality. A successful management of this entity requires fast and correct diagnosis and prompt treatment.

To our knowledge we report the first case of gastric incarceration in an iatrogenic diaphragmatic hernia with consequent intrathoracic perforation and tension pneumothorax. Etiological was an open left hemihepatectomy for a benign tumor in a 71-year old male. In a combined thoraco-abdominal approach we successfully sutured the diaphragmatic defect and resected the stomach fundus.

In a comprehensive review of the literature we illustrate standards and pitfalls in diagnostics and treatment of diaphragmatic hernia in emergency setting. While most diaphragmatic hernias are congenital or posttraumatic, reports of iatrogenic diaphragmatic hernias are increasing. As an incarcerated diaphragmatic hernia is easy to miss, a high index of suspicion is necessary. Our case illustrates, that delayed presentation or diagnosis may lead to severe complications and that complicated diaphragmatic hernia present a big surgical challenge.

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## Introduction

Hernias of the abdominal wall are a common entity and generally require a surgical treatment. Among the different types of hernia Diaphragmatic Hernias (DH) are relatively rare. Nevertheless, a high index of suspicion is necessary for prompt diagnosis and surgical intervention, because incarcerated DH may cause severe complications with relevant morbidity and mortality.

Diaphragmatic hernias are mainly classified into two categories: congenital and acquired. There are several etiologies of acquired Diaphragmatic Hernia (DH): Traumatic, by blunt or penetrating abdominal or chest trauma, spontaneous by minor trauma like sneezing, coughing, labour or iatrogenic hernia. The overwhelming majority of about 80% [1] of DH are located on



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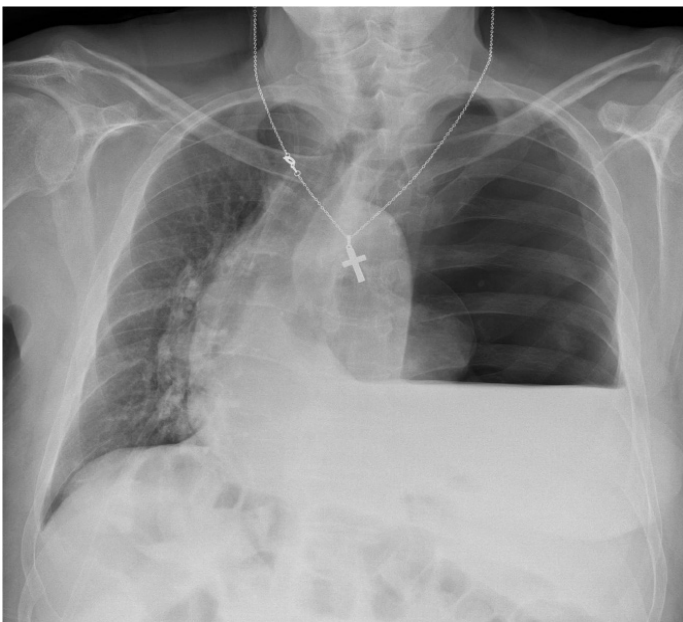
the left side and occur incidentally in 0.17% of asymptomatic patients [2]. Congenital Diaphragmatic Hernia (CDH) are generally symptomatic in newborn due to respiratory distress [3] and late-presenting of CDH is a rare phenomenon [4].

Traumatic rupture is the main reason for DH and is found in up to 8% of the cases of major abdominal trauma (traffic accident, fall from height, barotrauma, stab wound) with a ratio of 3:1 for penetrating to blunt trauma [5-7].

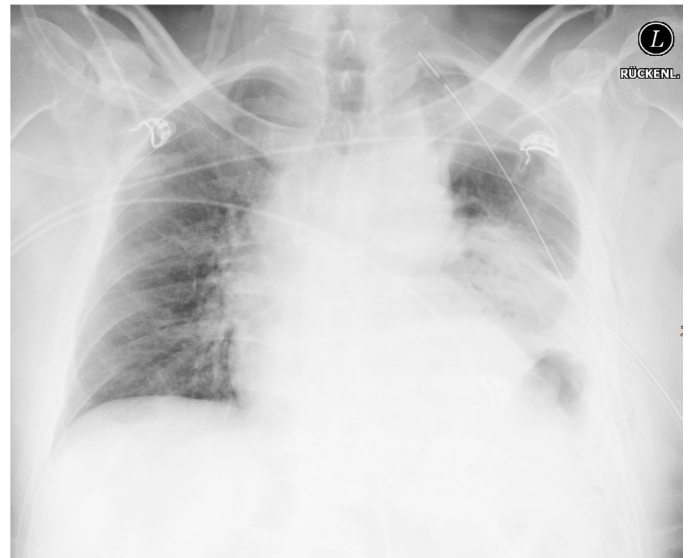
Iatrogenic injury is the second leading cause for acquired DH [8]. In our report we give a review of this entity and present a case of a left-sided DH after liver resection complicated by stomach gangrene and consecutive fecopneumothorax.

### Case report

A 71-year-old caucasian male presented in the emergency department of a local hospital with dyspnea and progressive breathlessness. The patient reported no history of abdominal or chest trauma. However, the patient had a history of left hemihepatectomy for a benign tumor nearly 6 months before. On physical examination the patient was conscious, oriented in time, place and person, but strongly distressed. He had a heart rate of 110 bpm, a blood pressure of 100/70mmHg and a respiratory rate of 25 breaths/min. Beside acute respiratory distress no other symptoms existed, even abdominal pain was denied. General examination revealed a left-sided hyperresonance and reduction of breath sounds. The patient was afebrile. Initial chest X-ray examination showed a left-sided tension pneumothorax with effusion and mediastinal shift (Figure 1). A chest tube was placed on the left side, leading to a release of air and fast improvement of the clinical condition. A second chest X-ray showed an extended left lung, with a still remaining effusion and a non-demarcated left diaphragmatic dome (Figure 2).

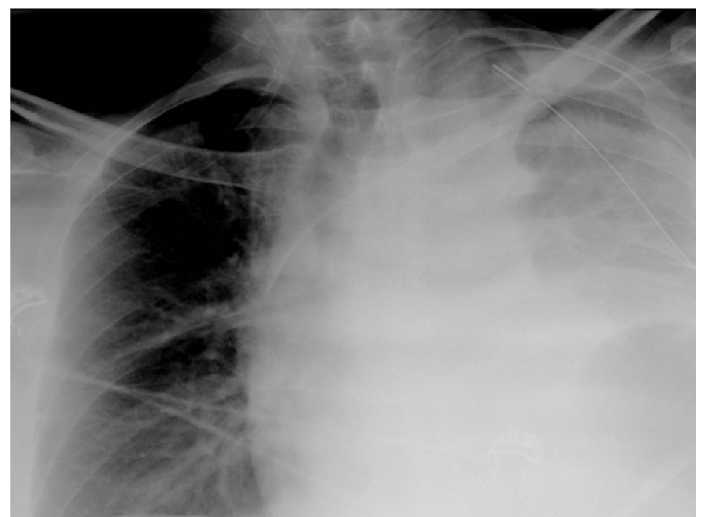


**Figure 1:** Initial chest X-ray showing a left tension pneumothorax with pleural effusion and mediastinal shift.



**Figure 2:** Chest X-ray demonstrating extended left lung, pleural effusion and chest tube.

After 3 days of surveillance in the intensive care unit the clinical condition aggravated severely. Clinical and laboratory data showed a septic condition. Remarkably, the chest tube drained feculent fluid. Another repeat chest X-ray revealed a left-sided DH with herniated stomach (Figure 3A). A multi slice CT scan of the thorax confirmed the diagnosis showing a posterolateral diaphragmatic hernia with intrathoracic perforation of the stomach and left-sided fecopneumothorax (Figure 3B). At that time the patient was referred to our center. The patient was immediately transferred to the operation theatre and an emergency surgery with a thoraco-abdominal approach was performed. The mid-line laparotomy revealed a left posterolateral diaphragmatic rupture of about 8 cm in size with strangulation of the stomach and focal gangrene of the stomach fundus and consequent perforation and spillage of gastric content into the pleural and abdominal cavity. Beside the stomach, the spleen had also herniated into the chest through the defect. After reduction of the herniated viscera into the abdominal cavity a sleeve resection of the fundus using linear tri stapler was performed. A capsular tear of the lower pole of the spleen was managed conservatively. The diaphragmatic defect was repaired by non-absorbable interrupted sutures. Due to contamination of abdominal cavity no mesh reinforcement was performed.



**Figure 3:** 3rd day after insertion of left chest tube: A) Chest X-ray showing gas bubble in the chest (according to stomach).



**Figure 3:** B) Computed tomography showing posterolateral diaphragmatic defect with herniated stomach.

Secondly a left-side thoracotomy was executed. An extensive lavage due to an empyema with nearly total collapse of the inferior lobe of the lung was indicated. Finally, two chest tubes were placed into the left thoracic cavity. The patient was treated with broad spectrum antibiotics. On the first day after the operation the patient did not need any support of inotropic substances, so he could be transferred from intensive care unit to surgical ward on the second postoperative day. A repeat CT scan showed bilateral pleural effusion. An additional chest tube was placed on the right side. A left-sided encapsulated interlobular effusion was drained by CT-guided puncture. The patient was discharged on the 23rd postoperative day and remains in a good condition 6 months later.

### Discussion

Diaphragmatic hernia is a rare complication after liver resection. Our patient had no history of blunt or penetrating trauma. However, the patient had a left hemihepatectomy due to a benign tumor occupying nearly the entire left lobe 6 months before the reported event. Neither the MR imaging before, nor the CT scan after the procedure revealed a DH. Therefore, a late-onset congenital or spontaneous DH seems to be widely excluded. As a conclusion in our case an iatrogenic etiology of the DH is most probable. We hypothesize that the stomach incarcerated into the diaphragmatic defect. First, the consequent focal perforation lead to release of gas and the development of the tension pneumothorax. Secondly, food and fecal material were released into chest cavity with a delay of 3 days with commencement of oral food intake and growing gangrenous defect of the stomach.

### Clinical presentation of diaphragmatic hernia

The leading causes of acquired diaphragmatic hernia are penetrating and blunt trauma, followed by iatrogenic diaphragmatic hernia. Both entities have in common that patients can be asymptomatic in up to 50% [9]. This can result in a delayed presentation and is associated with relevant morbidity and mortality [6,10,11]. In cases of incarcerated viscera an emergency surgical approach is mandatory for a good outcome. The most common clinical signs of a DH are abdominal symptoms with pain (68%) and obstruction (39%) or pulmonary symptoms (37%). Overall 14% of adult with Bochdalek hernia are asymp-

tomatic [1]. The majority of patients present with acute occurrence of symptoms. Even some individual reports of sudden death have been reported [12].

Different organs may herniate into the diaphragmatic defect: Most common are the stomach, right hepatic lobe, transverse colon, spleen, small bowel and omentum [11]. Herniation of visceral organs may lead to viscerothorax mimicking pneumothorax. The majority of those cases represented complications of traumatic DH with acute [13,14] or delayed presentation [15]. Several authors reported cases of incarcerated DH with gastrothorax with [13,16,17] or without tension component [5,18]. A prolonged herniation of the stomach can result in a focal gangrene of stomach [16]. Due to the clinical and radiological similarity of gastrothorax and tension pneumothorax it can be difficult to differentiate the two conditions. A presumed pneumothorax can lead to an inappropriate intervention. Reported cases of misdiagnosis and subsequent chest tube insertion had fatal consequences with gastric [17] or colon perforation [19,20]. In tension gastrothorax, the insertion of a nasogastric tube leads to a release of trapped air and to a hemodynamic stabilization of the patient. Hence, the patient can be transferred to operation theater in a stable condition [10,15]. All those cases have in common that authors recommend an immediate surgical intervention in order to reduce viscera into abdominal cavity and perform resection of gangrenous parts of incarcerated organs.

In our case, the patient presented exclusively with pulmonary symptoms triggered by the tension pneumothorax. Remarkably, pathologic fluid was drained by the chest tube only on the 3rd day after insertion, after the patient started eating and drinking. In literature few more cases with similar presentation exist. CDH with delayed presentation and consecutive focal gangrene of the stomach with following tension pneumothorax [21] and traumatic DH presenting as haemopneumothorax with delayed drainage of gastric content have been reported [22]. Incarcerated colon in DH after blunt [23] or penetrating [24,25] abdominal trauma presenting with fecopneumothorax with or without aspect of tension are reported likewise. In conclusion, spontaneous tension fecopneumothorax as a result of incarcerated DH is a very rare finding and our case seems to be the first reported case of iatrogenic hernia with this clinical presentation.

### Review of iatrogenic diaphragmatic hernia

The second most common etiology of acquired DH is by iatrogenic injury. Cases of iatrogenic DH have been reported after nearly every operation of the upper gastrointestinal tract, including laparoscopic surgery e.g. gastrectomy, cholecystectomy, as well as laparotomy e.g. open splenectomy and liver resection [26-28]. In retrospective studies of up to 993 patients who underwent major hepatectomy for liver tumors the incidence of DH was 0.6–3%, with a mean delay of symptomatic presentation of 19 months. In these studies liver resection site and location of consecutive DH were right-sided in 74%-91% of the cases [29-31].

To date only a few reports of left-sided DH after major hepatic resection exist. In these cases patients developed DH after open left hemihepatectomy for living donor liver transplantation [32], after laparoscopic left hemihepatectomy for metastasis of colorectal carcinoma [8] and focal nodular hyperplasia [33]. Large tumors and tumor infiltration of the diaphragm have been identified as main risk factors for the development of DH after liver resection [31]. Furthermore iatrogenic DH have been reported after radio frequency ablation for hepatocellular carcinoma



[34]. This suggests that thermal damage of the diaphragm during surgery is a possible reason for iatrogenic diaphragmatic defects. The different pressure levels in the thoracic and abdominal cavity can enlarge those lesions to greater defects. This would also explain the delay of herniation and clinical symptoms in this entity.

### Diagnostic approaches

While clinical presentation of DH strongly varies and can range from asymptomatic patient to patients with sudden death, a systematic diagnostic approach is necessary for diagnosis. Apart from physical examination radiologic studies are essential in evaluation of a patient with suspected DH. The diagnostic can be difficult because of thin muscle shape, the horizontal in-phase orientation of the diaphragm and associated abnormalities of lung bases. First-line diagnostic tool is the plain chest radiography that is diagnostic in 52-69% [35,36]. The sensitivity can be increased significantly by repetition and by insertion of a nasogastric tube [10,36]. Findings suggestive of DH in the chest radiography are the elevation of the left diaphragmatic dome, gas bubbles in the left hemithorax, intrathoracic abdominal viscera and projection of the tip of a nasogastric tube above the left hemidiaphragm [14]. Most effective diagnostic tool for diaphragmatic hernia is the multi slice computed tomography with sagittal, coronal and 3D reformatted images. Especially in traumatic DH CT scan allows the diagnosis of eventual concomitant intrathoracic or abdominal injuries [37]. In the literature sensitivity of helical CT scan in the diagnosis of DH was about 71%, with a higher sensitivity for left-sided DH (78%) compared to right-sided DH (50%) [38]. The most sensitive signs for DH were intrathoracic herniation of abdominal organs for left-sided DH and a diaphragmatic thickening for right-sided DH, respectively. The specificity of CT scan in diagnostic of DH was up to 100%. The most specific signs of DH are the collar sign (waist like constriction of herniated organs) and the "dependent viscera" sign, where herniated organs lay in contact with the posterior ribs [39]. In selected cases of uncertain diagnosis or in case of recurrence MR imaging or video-assisted thoracoscopic surgery (VATS) can be useful in diagnostic. In emergency case multi slice CT scan can be considered as the gold standard in diagnostic of DH.

### Surgical approaches and methods

Most authors recommend hernia repair for all congenital and acquired DH regardless of symptoms to prevent hernia incarceration [4,40-42]. Due to pressure difference between abdominal and thoracic cavity and constant motion of the diaphragm DH have no tendency towards spontaneous resolution. In contrast, congenital or acquired defects tend to enlarge over time. Surgical approaches include traditional open technique and minimal invasive approaches and include hernia reduction and defect closure. In elective setting laparoscopic and thoracoscopic approaches are established methods. Advantages of minimal invasive surgery are lessened postoperative pain, a good cosmetic result, rapid recovery with shorter hospital stay and earlier return to full activity. Most of diaphragmatic hernia are amenable for laparoscopic repair, including repair of CDH in adult [43] or chronic traumatic DH [40]. A hernial sac was only found in about 10% of the cases and it can be excised or left without difference in outcome [41]. Alternatively, a thoracoscopic access can be chosen. Safety and feasibility of this approach have been largely demonstrated as well in children as in adults with the advantage of easier removal of adherence to the lung [44].

In cases of incarcerated diaphragmatic hernia prompt surgical intervention is necessary to prevent potentially fatal outcome. Testini et al. gave an overview of over 700 reported cases of symptomatic diaphragmatic hernia necessitating emergency surgery [42]. A potential benefit of the laparoscopic approach in this setting could be the feasibility to explore both hemidiaphragm and to exclude concomitant intraperitoneal injuries [40]. Few cases of laparoscopic diaphragmatic repair in emergency setting have been reported in literature though. These include a strangulated stomach in a pregnant woman [45], gastric volvulus [46] and strangulated colon [20]. Other authors chose a combined thoracoscopic and laparoscopic method for treatment of a complicated Bochdalek hernia with colon perforation [47].

For emergency cases laparotomy was the most common approach [1,11]. In DH after major liver resection an open approach by laparotomy was chosen in 67% of the cases [29]. In our case we chose a combined open thoraco-abdominal approach due to an instable patient with intrathoracic perforation. After tension free primary repair of the diaphragmatic defect we renounced prosthetic reinforcement due to manifest contamination of both abdominal and thoracic cavity.

In large diaphragmatic defects that are not amenable to primary repair mesh reinforcement should be considered. A recommendation exists for defects larger than 10cm [31]. The most commonly used materials are composed of non-absorbable synthetic polymers such as polytetrafluoroethylene, polypropylene and polyethylene terephthalate. The advantage of a decreased risk of recurrence after mesh implantation is opposed to serious complications including infection, bowel fistula, migration of the mesh and perforation as seen in hiatal hernias [48]. Secondly prosthetic mesh cause higher costs. These issues have been widely discussed in literature and no consensus has been achieved so far. Neither method (primary repair, prosthetic mesh) has been demonstrated to be superior. Direct closure without reinforcement remains the most popular method (70-80%) [29,45]. Therefore, we conclude that the choice of approach and method of repair has to be taken individually and depends on preference and experience of the treating surgical team.

The use of meshes in potentially contaminated surgical fields is still in debate. Some complications as infection or migration can probably be avoided by use of absorbable prosthetic materials as lactic acid polymers or lactic and glycolic acid copolymers. However, use of those materials is accompanied with high risk of hernia recurrence. Recently some authors suggested the use of biological materials e.g. human acellular cadaveric dermis or porcine small intestine submucosa, for repair of the abdominal wall in contaminated surgical fields [7,49].

Due to rarity of this entity there are limited outcome and follow-up data available. The largest experience in DH treatment results from long-term studies of traumatic DH. In traumatic DH morbidity is reported in a range from 13 to 27% and overall mortality ranges from 1 to 28% depending on associated injuries [6,35,50]. The most common acute complications are the development of pneumonia, pleural empyema and wound infection [24,50]. In studies with small number of cases hernia recurrence ranged from 0 to 10% depending on localization and size [3,31,43]. While results of long-term studies are not available further experimental and clinical research is required in regard of infection rates, long-term complications and hernia recurrence.

## Conclusion

Iatrogenic diaphragmatic hernia is a rare but potentially life-threatening clinical entity. Incarceration of DH with consecutive complications due to gangrene of viscera is associated with relevant morbidity and mortality. In some case it might be difficult to differentiate between pneumothorax and viscerothorax. To prevent delayed diagnosis and to avoid iatrogenic complications for example by chest tube insertion a high index of suspicion for DH is necessitated, especially in patients with combined abdominal and respiratory symptoms. The presented case report emphasizes the importance of differential diagnosis of respiratory distress in patients with history of abdominal surgery, as well as in patients with history of blunt or penetrating abdominal trauma. CT scan is the gold standard for diagnostic in emergency setting and prompt surgical intervention is indicated.

## Ethical approval

Written improved consent was obtained from the patient for publication of this case report and accompanying images.

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