Thoracotomy for Traumatic Diaphragmatic Hernia

Zhang Fangbiao¹ · Zheng Chunhui¹ · Zhao Chun¹ · Shi Hongcan² · Zhang Xiangyan¹ · Tu Shaosong¹

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Abstract The aim of this retrospective study is to review our experience in the diagnosis and role of thoracotomy for traumatic diaphragmatic hernia (TDH). Between January 2008 and June 2014, 23 patients from Yangzhou Medical College (Yangzhou China) and Lishui Center Hospital (Lishui China), who underwent thoracotomy for TDH, were analyzed. The clinical features, imaging findings, operative findings, and outcome of treatment in these patients are presented. There were 23 patients (18 males and 5 females) who underwent surgical procedures due to TDH. The median age of the patients was 43.2 years (range, 15–68 years). The cause of rupture was penetrating trauma in 1 (4.3 %) patient and blunt trauma in 22 (95.7 %) patients. The TDH was left sided in 21 patients and right sided in two patients. The diagnosis was made by chest X-ray ($n=2$) and chest or abdominal CT ($n=13$) and at thoracotomy based on a high index of suspicion ($n=8$). Associated injuries were seen in 21 patients (91.3 %). Twenty-two patients underwent thoracotomy, and one underwent thoracotomy with laparotomy. The mean operating time was 112 min (range, 60–185 min) and the mean blood loss was 116 mL (range, 20–400 mL). The most common herniated organs were the

omentum ($n=15$), stomach ($n=14$), spleen ($n=11$), colon ($n=10$), small bowel ($n=2$), and liver ($n=1$). All diaphragmatic defects were repaired using interrupted prolene sutures. The overall mortality rate was 4.3 % ($n=1$). The diagnosis of TDH is easily missed or delayed. Chest X-ray and computer tomography (CT), especially chest and abdominal CT, are useful in the diagnosis of diaphragmatic ruptures, and thoracotomy is an effective and successful treatment for TDH.

Keywords Trauma · Diaphragmatic hernia · Thoracotomy · Associated injuries · Herniation abdominal contents

Introduction

Traumatic diaphragmatic hernia (TDH) is an uncommon and serious thoracic disease that results from penetrating or blunt thoracic or abdominal injury. However, due to nonspecific clinical features and radiological findings, the diagnosis of TDH is easily delayed or missed. According to published reports, the incidence rate varied between 0.8 and 8 % and the mortality rate ranged from 16.6 to 33.3 % [1].

Diagnosis and surgical management of TDH remain challenging. As laparotomy is commonly performed following trauma, the most common approach for treatment of TDH is laparotomy [2]. However, according to some published papers, thoracotomy has also been performed to treat TDH [3]. In our study, we analyzed the clinical presentation, thoracotomy management, and outcome of treatment of 23 patients with TDH and reviewed our experience with the diagnosis and treatment of these patients.

Zhang Fangbiao, Zheng Chunhui, Zhao Chun and Shi Hongcan contributed equally to this work.

✉ Tu Shaosong
tushaosong9@126.com

¹ Department of Cardiothoracic Surgery, Lishui Center Hospital, Tu Shaosong, 289 Kuocang Road, Lishui, Zhejiang Province 323000, People's Republic of China

² Department of Cardiothoracic Surgery, Clinical College, Yangzhou University, Yangzhou, Jiangsu 225001, People's Republic of China

Patients and Methods

Twenty-three patients from Subei People's Hospital (Yangzhou China) and Lishui Center Hospital (Lishui, China), who underwent thoracotomy for TDH between January 2008 and June 2014, were reviewed. Clinical information from hospital records, including age, sex, clinical presentation, associated injuries, method of diagnosis, time from injury to diagnosis, operative time, approach, findings, blood loss, postoperative course, complications, duration of hospital, and mortality, was retrospectively reviewed.

All patients presented in the emergency department and underwent routine examination, including routine blood tests, coagulation profile, electrolytes, chest X-ray, or chest-abdominal CT. Once the diagnosis of TDH is suspected or confirmed, the patients were immediately ready for thoracotomy depending on the site of injury and imaging features. The herniated tissues and the defect in the diaphragm were assessed. After the abdominal contents were reduced through the defect, the diaphragmatic defect was repaired using interrupted prolene sutures.

Results

Patient Features

In our study, there were 23 patients (18 male and 5 female) who underwent thoracotomy for TDH with ages ranging from 15 to 68 years. The mean age was 43.2 years. Blunt injuries were the cause of TDH in 22 patients and included 11 road traffic accidents, two vigorous exercises, two workers pressed by stone, and seven patients who gave history of fall. One patient had penetrating trauma caused by chop injuries. The site of TDH was on the left in 21 patients and on the right in two. Patients presented with symptoms related to the site of injury. Seventeen patients presented main symptoms, including chest pain ($n=12$, 52.2 %), upper abdominal pain ($n=9$, 39.1 %), dyspnea ($n=4$, 17.4 %), cough ($n=2$, 8.7 %), and vomiting ($n=1$, 4.3 %) (Table 1).

Associated Injuries

Eighteen patients presented with associated injuries, including rib fractures ($n=13$, 56.5 %), lung laceration ($n=11$, 47.8 %), scapula fracture ($n=1$, 4.3 %), spine vertebral fracture ($n=9$, 39.1 %), tibia fracture ($n=2$, 8.7 %), lienal rupture ($n=2$, 8.7 %), pelvic fracture ($n=4$, 17.4 %), and head injury ($n=2$, 8.7 %) (Table 2).

Table 1 Clinical features

	Number	Percentage
Mechanism of injury		
Blunt	22	95.7 %
Penetrating	1	4.3 %
Main symptoms		
Chest pain	12	52.2 %
Upper abdominal pain	9	39.1 %
Dyspnea	4	17.4 %
Cough	2	8.7 %
Vomit	1	4.3 %
Main physical signs		
Respiratory distress	4	17.4 %
Bowel sounds in chest	3	13 %
Abdominal tenderness	6	26.1 %
Methods of diagnosis		
Chest X-ray	2	8.7 %
CT scan	13	56.5 %
Intraoperative	8	34.8 %
Time of diagnosis		
<24 h	12	52.2 %
>24 h, <48 h	6	26.1 %
>48 h	5	21.7 %

Preoperative Diagnosis and Treatment

The method for the diagnosis for TDH was chest X-ray in two (8.7 %), chest CT in ten (43.5 %), abdominal CT in three (13 %), and intraoperative exploration in eight (34.8 %) patients based on a high index of suspicion. Imaging studies showed herniation of the abdominal organs into the pleural cavity (Fig. 1).

Operative findings

Twenty-two patients underwent thoracotomy, and one underwent thoracotomy associated with laparotomy. The mean operating time was 112 min (range, 60–185 min) and

Table 2 Associated injuries

Associated injuries	Number	Percentage
Multiple rib fractures	13	56.5 %
Lung lacerations	11	47.8 %
Scapula fractures	1	4.3 %
Spine vertebral fractures	9	39.1 %
Tibia fractures	2	8.7 %
Lienal ruptures	2	8.7 %
Pelvic fractures	4	17.4 %
Head injury	2	8.7 %

Fig. 1 Chest X-ray showing the stomach in the left pleural cavity

the mean blood loss was 116 mL (range, 20–400 mL). The most common herniated organs were the omentum ($n=15$), stomach ($n=14$), spleen ($n=11$), colon ($n=10$), small bowel ($n=2$), and liver ($n=1$) (Table 3). The average length of ruptured diaphragm was 10 cm (range, 2–20 cm). All diaphragmatic defects were repaired using interrupted prolene sutures. Splenectomy was performed in two patients and lung wedge resection in one to achieve hemostasis.

Postoperative Complications

The postoperative complications included wound infection ($n=1$, 4.3 %), pneumonia ($n=4$, 17.4 %), empyema ($n=2$, 8.7 %), and anemia ($n=5$, 21.7 %). All postoperative complications were treated successfully, except one patient died due to serious pneumonia. Intercostal tube drains were removed in 3.6 days (range, 2–8 days). The mean length of postoperative hospital stay was 10.5 days (range, 7–22 days). All the survivors are on follow-up and there was no recurrence (Table 4).

Discussion

Traumatic diaphragmatic hernia (TDH), resulting from either blunt or penetrating trauma, is extremely rare and a potentially life-threatening condition. Nowadays, with the increasing

Table 4 Postoperative data

Postoperative data	Number	Percentage
Complications		
Wound infection	1	4.3 %
Pneumonia	4	17.4 %
Empyema	2	8.7 %
Anemia	5	21.7 %
Postoperative hospital stay (days)	10.5 (7–22)	–
Time of intrathoracic drain (days)	3.6 (2–8)	–
Recurrence rates	0	–

number of cars and high-rise buildings, the incidence of road traffic accidents and falls is rising every day. Because of the lack of any protection from the compressing forces transmitted from the blunt trauma, the frequency of TDH in the left hemidiaphragm is higher than in the right side [4]. Approximately 65 % of diaphragmatic ruptures occur on the left side [5]. In our study, 91.3 % of diaphragmatic ruptures occurred on the left side.

The symptoms of TDH include chest pain, upper abdominal pain, breathlessness, and vomiting, but are nonspecific. The symptoms of the respiratory system and digestive system appearing at the same time are very helpful in making the diagnosis. However, some patients may be asymptomatic after trauma. The diagnosis is often delayed or missed. The most common mode of presentation is chest pain or upper abdominal pain with breathlessness [3]. Therefore, the detailed history and careful physical examination for diagnosis are necessary.

The diagnosis of TDH represents a challenge for both the surgeon and the radiologist. The differential diagnosis of TDH includes many diseases which share similar clinical characteristics and radiographic findings. Therefore, the diagnosis of TDH is easily delayed or missed. It is sometimes too late when symptoms become obvious and the condition worsens. However, in recent decades, with the development of digital and high-resolution equipment, many investigative techniques have been used and are helpful for diagnosis of TDH, including chest X-rays; high-resolution, multislice computed tomography (CT) scan; magnetic resonance imaging (MRI); laparoscopy; and thoracoscopy. Chest X-rays, despite technical limitations and low sensitivity, are still used as the first step for the diagnosis of TDH [6]. In our present paper, the diagnosis was made by chest X-ray in two patients. CT is an important tool in the diagnosis of TDH. According to previous reports, CT is reported to have a sensitivity of 71 % (78 % for left-sided and 50 % for right-sided injuries), an accuracy of 88 % for the left and 70 % for the right, and a specificity of 100 % [6, 7]. The best imaging method to diagnose TDH is spiral CT with sagittal and coronal reconstructed images [7, 8]. Classical imaging findings include the “collar sign,”

Table 3 Operation findings

Herniated organs	
Omentum	15
Stomach	14
Spleen	11
Colon	10
Small bowel	2
Liver	1
Operation time (min)	112 (60–185)
Blood loss (mL)	116 (20–400)
Length of rupture diaphragm (cm)	10 (2–20)

discontinuity of the diaphragm, herniation of abdominal organs into the pleural cavity, and abnormally thickened diaphragmatic crus [7, 8]. MRI is uncommonly used for diagnosis of TDH, as it is time consuming and TDH is potentially life threatening. In our study, the method for the diagnosis of TDH was chest X-ray in two, chest CT in ten, abdominal CT in three, and intraoperative exploration in eight patients based on a high index of suspicion.

The most successful and effective treatment for TDH is surgery. Many surgical approaches including thoracotomy, laparotomy and thoracotomy with laparotomy, video-assisted thoracic surgery, and laparoscopy are used for treatment of TDH. Laparotomy, due to the complete exploration of the abdominal viscera, is the most common approach for treatment of TDH [2]. However, when there are no abdominal injuries, it is easier to reduce the herniated tissues and repair the diaphragm via a thoracotomy [3]. In our paper, all the patients underwent thoracotomy successfully except one case. The defective diaphragm was easily repaired via thoracotomy. With the development of minimally invasive surgical technology, more and more surgical interventions are performed by minimally invasive approach due to less pain and less blood loss [9–11]. Latic F [12] reported a case of a 56-year-old man who sustained blunt abdominal trauma in a high-speed motor vehicle accident. The herniated abdominal organs were placed back into the abdomen, and the defect was repaired with interrupted sutures; splenectomy was performed via a laparoscopy. This case demonstrates that laparoscopy is an effective and successful approach for TDH. But this should be carried out with caution. Parelkar SV [13] reported two children in whom video-assisted thoracic surgery led to successful repair of traumatic diaphragmatic hernia. Because there are few cases reported by the minimally invasive approach, more research is needed.

The mortality rates of TDR range from 16.6 to 33.3 % [1]. In our cases, the mortality rate is 4.3 %. However, there is no paper comparing mortality in thoracotomy versus laparotomy. More studies are needed to study the benefits of thoracotomy.

Most of the studies have not presented recurrence rates following surgery. In our study, all the survivors are on follow-up and no recurrence has been noted. In my opinion, the method of suture is crucial for recurrence rates. The diaphragmatic defects should be repaired with nonabsorbable “figure-of-eight suture.” When the defect is large, mesh repair is needed to complete tension-free repair [14, 15]. Long-term follow-up with radiological imaging and ultrasonography are also required to monitor the recurrence of diaphragmatic hernia.

In conclusion, the preoperative diagnosis of TDH is still a challenge. Once the diagnosis of TDH is suspected or confirmed, thoracotomy or laparotomy is required immediately. In our cases, herniated abdominal organs were placed back into the abdomen and the defect was successfully repaired with interrupted sutures via a thoracotomy. This retrospective study showed that thoracotomy of TDH is successful and effective, but sometimes, it needs an additional complex procedure like enterectomy or splenectomy.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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