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Management of Traumatic Diaphragmatic Rupture

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Abstract

Purpose. Diaphragmatic rupture following trauma is often an associated and missed injury. This report documents our experience of treating traumatic diaphragmatic rupture (TDR).

Methods. We retrospectively analyzed 18 patients who presented between 1993 and 2000 with TDR, caused by blunt injuries in 14 and by penetrating injuries in 4.

Results. The average age of the patients was 32 years and the female to male ratio was 4:14. The TDR was right-sided in 5 patients and left-sided in 13. The diagnosis was made by chest X-ray, thorax and upper abdominal computed tomography, and upper gastrointestinal contrast studies. The most common herniated organs were the omentum ($n = 11$), stomach ($n = 10$), spleen and colon ($n = 9$), and liver ($n = 2$). Sixteen diaphragmatic injuries were repaired primarily, and two were repaired using a prolene mesh graft. The mortality rate was 5.5% ($n = 1$).

Conclusions. A high index of suspicion and early surgical treatment determine the successful management of TDR, with or without the herniation of abdominal organs. The surgical approach to TDR is individualized. Acute left-sided injuries are best approached through the abdomen, although we prefer the chest approach, adding laparotomy when necessary. Acute right-sided injuries and chronic injuries should be approached through the chest.

Key words Traumatic diaphragmatic rupture · Diagnosis · Emergency thoracotomy

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Introduction

The diaphragm is the major muscle of ventilation and the second most important muscle in the body after the heart. Traumatic rupture of the diaphragm, while uncommon, presents a challenging emergency. A delayed or missed diagnosis at the time of initial injury and the life-threatening catastrophic sequelae if left untreated for long compound the problem.[1,2] We review our experience of treating TDR to identify the predictors of outcome, and the factors contributing to diagnostic delay.

Patients and Methods

We retrospectively reviewed 18 patients admitted to our hospital with TDR between 1993 and 2000. The variables studied in relation to the outcome were age, sex, mechanism of injury, hemodynamic status at admission, method of diagnosis, TDR side, imaging studies performed, associated injuries, herniated organs, hospital course, associated complications, and mortality.

Results

The clinical features of the 18 patients are listed in Table 1. The mean age of the patients was 32 years, with a range of 17–65 years. There were 14 men and 4 women. The cause of injury was blunt trauma in 14 patients (77.7%) and penetrating trauma in 4 patients (12.3%).

The blunt injuries were caused by motor vehicle accidents (including pedestrians hit by cars), falls, and crush injuries. The penetrating injuries included a gunshot wound and three stab wounds. The anatomic distribution of injury to the diaphragm consisted of 5 right-sided injuries (27.7%) and 13 left-sided injuries (72.3%). The

Table 1. Demographics and clinical characteristics of the patients with traumatic diaphragmatic rupture

Patient no.	Sex	Age (years)	Side	Type of injury	Diagnosis	Application	Operation	Complications	Stay (days)
1	M	22	L	P	IO	LT	G + S	Hemorrhage	16
2	M	42	R	B	PA + CT	T	P + H	—	11
3	M	17	L	B	PA	T	P	—	8
4	F	25	R	B	PA + CT	T	P + PW	Pneumonia	18
5	M	51	R	B	PA + CT	T	P + H	—	10
6	M	20	L	P	IO	LT	G + S	—	Died (IO)
7	F	31	L	B	PA + CT	T	P	UTI	12
8	M	19	L	B	PA	T	P	—	7
9	M	26	L	B	PA + CT + BE	T	P	—	9
10	M	34	L	P	PA + CT + BE	LT	P + O	—	12
11	F	24	L	B	PA + CT	T	P	—	10
12	M	65	R	B	PA + CT	T	P + PW	Empyema	45
13	M	41	L	B	PA	T	P	—	9
14	M	21	L	P	PA + CT	LT	P + G	—	12
15	F	47	L	B	PA + CT + BE	T	P	—	10
16	M	21	L	B	PA	T	P	—	9
17	M	39	L	B	PA + CT + BE	T	P	—	10
18	M	31	R	B	PA + CT	T	P + PW	Pneumonia	13

P, penetrating; B, blunt; IO, intraoperative; PA, posteroanterior chest X-ray; CT, computed tomography; BE, Barium enema; G, Graft; P, primer; S, splenectomy; H, hepatorrhaphy; PW, pulmonary wedge resection; O, omentoplasty; G, gastrorrhaphy; T, thoracotomy; LT, laparothoracotomy; UTI, urinary tract infection

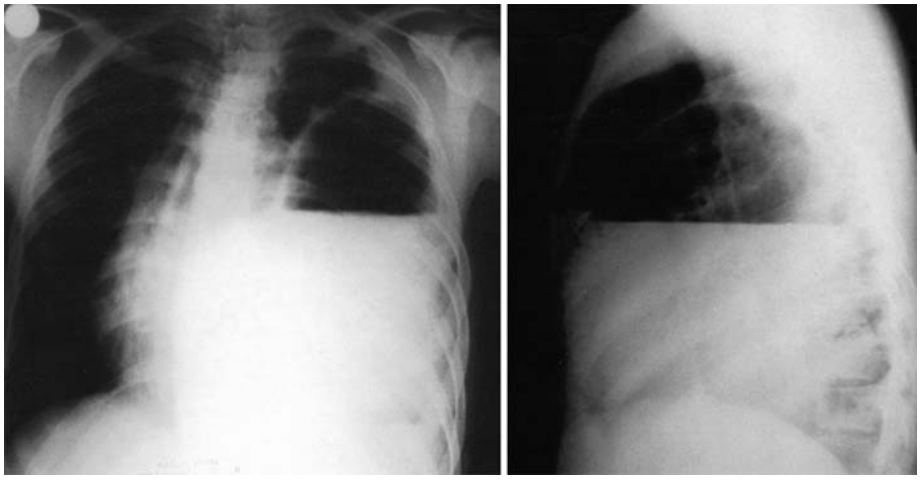

Fig. 1. Chest X-ray showed irregularity of the diaphragmatic dome on posteroanterior (**a**) and left lateral (**b**) views

interval between injury and diagnosis was less than 48 h in 15 patients (83.3%) and longer than 48 h in 3 patients (16.7%). A preoperative diagnosis was made in 16 patients (88.8%), based mainly on chest X-ray findings and partly on physical examination (Fig. 1). Computed tomography (CT) performed in 16 patients supported the diagnosis in 12 (75%) (Fig. 2), and was equivocal in 4 (25%). In four patients with an isolated TDR, the initial chest X-ray and CT findings suggested TDR, and diagnosis was confirmed by upper gastrointestinal (GI) contrast studies (Fig. 3). An intraoperative diagnosis of TDR was made in two patients (11.2%). One of these patients, who was shocked, underwent emergency surgery despite poor vital signs. Exploration revealed that the stomach, bowel, and spleen were in the thorax and the bowels were strangulated. This patient died during the operation.

The associated injuries seen in the patients with blunt TDR included multiple rib fractures in 4 (28.5%), pulmonary lacerations in 3 (21.4%), liver lacerations in 2 (14.2%), spleen lacerations in 2 (14.2%), gastric perforation in 1 (7.1%), bowel gangrene in 1 (7.1%), pelvic fracture in 1 (7.1%), vertebral compression fracture in 1 (7.1%), and a long bone fracture in 1 (7.1%). The associated injuries seen in the patients with penetrating TDR included liver lacerations in 2 (50%), and pulmo-

Fig. 2. Computed tomographic scan showed displacement of the colon within the thoracic cavity

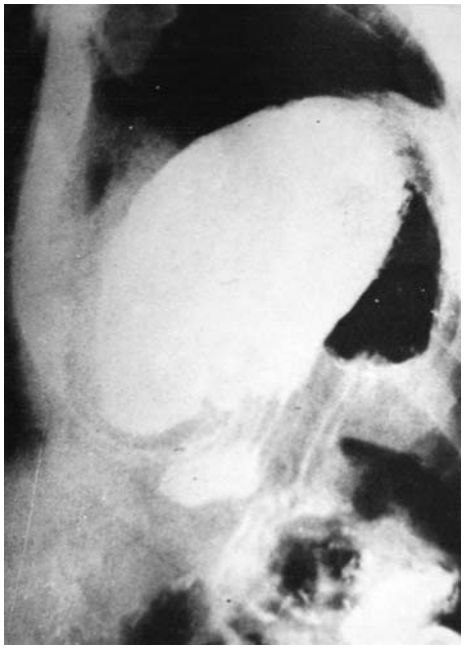

Fig. 3. Barium enema showed both the stomach and large bowel in the thoracic cavity

nary lacerations in 2 (50%). The most common herniated organs were the omentum (n = 11), stomach (n = 10), spleen and colon (n = 9), and liver (n = 2).

TDR repair was accomplished through a thoracotomy in 14 patients (77.7%) and through a laparothoracotomy in 4 patients (22.3%). Both interrupted and running techniques with nonabsorbable sutures were used. In 2 patients, a large diaphragmatic defect necessitated the use of prolene mesh. Management of the associated injuries in the 11 patients who survived the operation included splenectomy (n = 2), hepatorrhaphy (n = 2), gastrorrhaphy (n = 1), omentoplasty (n = 1), and wedge resection of the lung (n = 5). The length of hospitalization ranged from 7 to 45 days, with a mean stay of 13 days. The postoperative complications that developed in the survivors included pneumonia (n = 2, 11%), empyema (n = 1, 5.5%), hemorrhage (n = 1, 5.5%), and urinary tract infection (n = 1, 5.5%). The morbidity rate was 27.5% and the hospital mortality rate was 5.5%.

Discussion

Acute diaphragmatic rupture is being recognized more frequently, with a reported incidence of 0.8%–7% in association with blunt trauma and 10%–15% in association with penetrating trauma.[2,3] About 90% of diaphragmatic ruptures occur on the left side.[4] In our series, 72.3% were on the left side. Penetrating and blunt wounds of the diaphragm are classified according to the interval between the injury and when the diagnosis is made.[5,6] The initial presentation (acute phase) begins with the injury and lasts until the patient has recovered from the injury. If the injury is undiagnosed in the acute phase, the patient enters an interval (latter period) that may last from days to several months. Finally, the patient may present with a chronic obstruction (obstructive phase), at which time reduction of the hernia contents and repair of the diaphragmatic defect is performed. A surgical emergency can result with symptoms caused by secondary incarceration or strangulation. This phase can occur anywhere from several months to 40 years after the event.[7] According to the literature, diaphragmatic hernias considered to be in the delayed period usually occurred after penetrating injuries.[8] In our series, 83.3% of the TDR were seen in the acute phase, and 16.7% were seen in the chronic obstructive phase. It is interesting that two of the patients were diagnosed to have TDR in the chronic obstructive phase; one 7 years postinjury and the other, 19 years postinjury.

Accurate diagnosis depends on a high index of suspicion, careful scrutiny of the chest X-ray in patients with thoracoabdominal or polytrauma, an meticulous inspection of the diaphragm during surgery for concurrent injuries. The ruptured diaphragm is frequently missed in the acute phase because of shock, respiratory insufficiency, visceral injuries, and coma.[1] The pathophysiologic effects of a ruptured diaphragm are related to circulation and respiration. This is due to the impaired

function of the diaphragm, compression of the lung, and displacement of the mediastinum with impairment of venous return to the heart.[9] In our series, the diagnosis of TDR was made preoperatively in 88.8% (16/18) of the patients and a delayed diagnosis was made in 16.7% (2/18) of the patients.

Many investigative techniques have been described for the diagnosis of TDR,[10] including chest X-ray, CT scan, magnetic resonance imaging, upper GI contrast studies, angiography, ultrasonography, thoracoscopy, peritoneal lavage, and laparoscopy. In most instances, careful examination of clear chest X-ray films will suffice.[11] Sensitivity of the initial chest X-ray interpretation can be increased by heightened awareness of this injury.[12] However, we diagnosed only two patients (16.6%) with chest X-ray alone. Computed tomography scan is the second choice of imaging technique, although the axial-oriented diaphragm is not always well demonstrated by conventional CT. Wide ranges of sensitivity and specificity have been reported as 54%–73% and 86%–90%, respectively.[13] In our series, a CT diagnostic value of 75% was obtained. The most commonly used preoperative imaging studies, namely, initial chest X-ray and CT, are diagnostic in 30%–50% of cases.[3] Studies have shown that magnetic resonance imaging (MRI) is helpful in equivocal cases TDR.[14] In our series, MRI was not used, although upper GI contrast studies proved helpful in the diagnosis of four patients.

The overall mortality rate reported in the present series was 5.5%. According to the literature, mortality rates vary from 1% to 28%.[15] The associated injuries are invariably responsible for the high mortality. Predictions of increased mortality include age greater than 55 years, major comorbid illness, and the number and severity of associated injuries to major body systems, with central nervous, cardiovascular, and intra-abdominal injuries carrying the greatest associated morbidity and mortality.[3,16]

Traumatic diaphragmatic rupture belongs to the category of diseases for which urgent surgical intervention is the required treatment. The choice of surgical approach, namely, thoracotomy, laparotomy, or both, depends greatly on the associated injuries and trauma-related syndromes.[17,18] In our opinion, the surgical approach to TDR can vary from case to case. Although acute left-sided injuries are usually best approached through the abdomen, we prefer the chest approach, but add laparotomy when necessary. Acute right-sided injuries and chronic injuries should be approached through the chest. The occasional very large diaphragmatic defect may require closure with a nonabsorbable patch.

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