

Traumatic diaphragmatic hernias: a report of 26 cases

T.Z. Nursal¹, M. Ugurlu², M. Kologlu² and E. Hamaloglu²

¹Baskent University, General Surgery Department, Dr. Turgut Noyan Research Hospital, Adana, Turkey

²Hacettepe University Hospital, General Surgery Department, Ankara, Turkey

Abstract: Traumatic diaphragmatic hernias, when diagnosed many years after the traumatic event, are observed in about 10% of diaphragmatic injuries. Due to coexisting injuries and the silent nature of diaphragmatic injuries, the diagnosis is easily missed or difficult. The medical records of 26 patients, who were treated for diaphragmatic hernias during the last 20 years, were analysed retrospectively. The patients were divided into acute phase and late-presenting groups, in whom emergency surgery and elective intervention were performed respectively. Chest radiography was diagnostic in 34.6% (n = 9) of patients. 92.3% of the hernias were on the left side, while the most common herniated organs were the stomach (31.8%) and the colon (27.2%). Coexisting injuries were recorded in 38.4% (n = 10) of the patients. Primary repair was predominantly used (92.3%). The hospitalisation period was longer in the late-presenting group (24.1 ± 18.8 vs. 14.3 ± 7.7 days). Two deaths occurred in the late-presenting group. Diaphragmatic hernia should be suspected in all blunt abdominal trauma patients. Prompt surgical repair is the treatment of choice in all traumatic diaphragmatic hernias.

Key words: Diaphragmatic hernia – Trauma – Blunt abdominal trauma

Correspondance to: T.Z. Nursal
e-mail: tznursal@hotmail.com

Received November 19, 1999

Accepted in final form November 22, 2000

Blunt trauma, due to motor vehicle accidents or to various other injuries, can cause multiple organ injuries. Recent advances in initial care and rapid emergency services in the trauma vicinity have increased the number of severely injured patients arriving at hospital. Diaphragm injuries are seen in 2 to 6% of trauma patients [Shires 1994, Lorimer 1994, Shah 1995]. The trauma which

causes diaphragmatic injury is usually severe enough to also cause other organ injuries [Symbas 1986] which may need urgent intervention. Unfortunately, these coexisting injuries can mask the more silent diaphragmatic injuries. Diaphragmatic hernias are diagnosed in only some 10% of cases in the acute phase [Brown 1985]. This is probably due to the prompt repair of intraoperati-

vely diagnosed diaphragmatic injuries in cases with penetrating injuries before any herniation occurs. A diaphragmatic injury, occasionally missed in the original accident, sometimes presents as a hernia many years later [Brown 1985]. We report 26 cases of traumatic diaphragmatic hernias which were diagnosed and treated during a 20-year period in a single health care institute.

Patients and methods

The medical records and surgical notes of twenty-six patients who were treated for diaphragmatic hernias between 1977 and 1997, were analysed retrospectively. The mean age of the patients was 35.0 ± 11.0 years, of whom 21 (80.8%) were male and 5 (21.2%) female. Nineteen patients (73.1%) were victims of blunt trauma, whereas 7 patients (26.9%) suffered from penetrating injuries (1 caused by a bullet wound, 6 by knives).

In all cases, plain chest and abdominal roentgenograms and blood biochemistry tests were taken. The diaphragmatic injuries were graded according to the organ injury scale of Moore [1995]. The Injury Severity Scores (ISS) of the patients were calculated by using the Abbreviated Injury Scores (AIS) for every injured organ. The patients were also evaluated in two groups. Group 1 consisted of 12 patients (46.2%) who underwent surgery during the acute phase of injury. The other 14 patients (53.8%) were placed in a late-presenting group, in whom diagnosis and treatment had been delayed from 3 months to 45 years. Six of these latter 14 patients were in an obstructive phase and eight in a latent phase.

The patients treated in the acute phase were operated on at 6.9 ± 9.6 hrs (median 2 hrs) after the trauma, whereas in the late-presenting patients diagnosis and treatment were delayed by 11.2 (median 6.7) years.

Results

Decrease in the respiratory sounds was the primary finding (17 of 26 patients), whereas dyspnea was the major symptom (12 of 26 patients) (Table 1). In four cases (15.3%), chest radiographs were normal. The remaining 22 patients presented with some pathologic finding in their chest radiographs (Table 2); but only 9 of the 26 patients had visceral gas in the thorax, which is pathognomonic of diaphragmatic hernia.

Elective laparotomy was performed in 8 of the 14 late patients and in 8 of the 12 emergency cases. The other 10 patients were operated on using thora-

Table 1. Symptoms and findings in diaphragmatic hernia patients

	Acute phase (n = 12)	Late-presenting (n = 14)	Total (n = 26)
Decrease in respiratory sounds	8 (66.7%)	9 (64.2%)	17 (65.3%)
Dyspnea	6 (50%)	6 (42.8%)	12 (46.1%)
Visceral sounds in thorax	3 (25.0%)	5 (35.7%)	8 (30.7%)
Abdominal pain	4 (33.3%)	4 (28.5%)	8 (30.7%)
Nausea-vomiting	1 (8.3%)	5 (35.7%)	6 (23.1%)

Table 2. Chest radiograph findings

	Acute phase (n = 12)	Late-presenting (n = 14)	Total (n = 26)
Visceral gas in thorax	4 (33.3%)	5 (35.7%)	9 (34.6%)
Diaphragm elevation	3 (25.0%)	6 (42.8%)	9 (34.6%)
Pneumothorax	3 (25.0%)	1 (7.1%)	4 (15.3%)
Rib fracture(s)	2 (16.6%)	0	2 (7.7%)
Hemothorax	2 (16.6%)	0	2 (7.7%)

Table 3. Organs herniated through the diaphragmatic defect

	Acute phase (n = 12)	Late-presenting (n = 14)	Total (n = 26)
Stomach	7	7	14 (31.8%)
Colon	4	8	12 (27.2%)
Omentum	2	5	7 (15.9%)
Intestines	2	4	6 (13.6%)
Spleen	3	0	3 (6.8%)
Liver	1	1	2 (4.5%)
Total	19	25	44 (100%)

cotomy. A combined thoraco-abdominal approach was not used. The majority of the injuries were on the left side (92.3%). Whereas only 2 patients (7.7%) had right-sided diaphragmatic hernias. No bilateral injuries were observed. The diaphragm was more seriously injured in blunt trauma patients. The mean diaphragm injury grade was 3.7 ± 0.9 in blunt traumas and 2.6 ± 1.2 in penetrating injuries.

In general, multiple organs herniated through the diaphragmatic defect. The number of the herniated organs ranged between 1 to 4 per patient. The most common herniated organ was the stomach (31.8%) (Table 3, Fig. 1). Coexisting injuries to other organs were observed in 10 (38.4%) patients in whom the spleen was the most commonly injured organ (6 patients); splenectomy was performed in those cases. In three of these patients the lung, kidney and gallbladder were also observed to be injured. Lung and kidney injuries were primarily

repaired; and cholecystectomy was also performed in one patient. In two other patients, the liver and colon were injured. These injuries were repaired primarily, but a proximal loop colostomy was performed for the patient with the left colon injury. Among the coexisting injuries, rib fractures were observed in 5 patients (all had blunt injuries).

The diaphragmatic defect was primarily repaired in 24 patients (92.3%). Two synthetic grafts were used for repair in the late-presenting patients. The defects in these latter patients were larger than 10 cm in their long axis. Because of tissue loss, the primary repair could cause excessive tension on the suture line. Therefore, polypropylene grafts (10 x 15 cm) were sandwiched between the redundant layers of the peritoneum.

The mean ISS of patients suffering from blunt and penetrating trauma in the acute phase group was 22.6 ± 9.3 and 19.0 ± 8.9 , respectively. The late-presen-

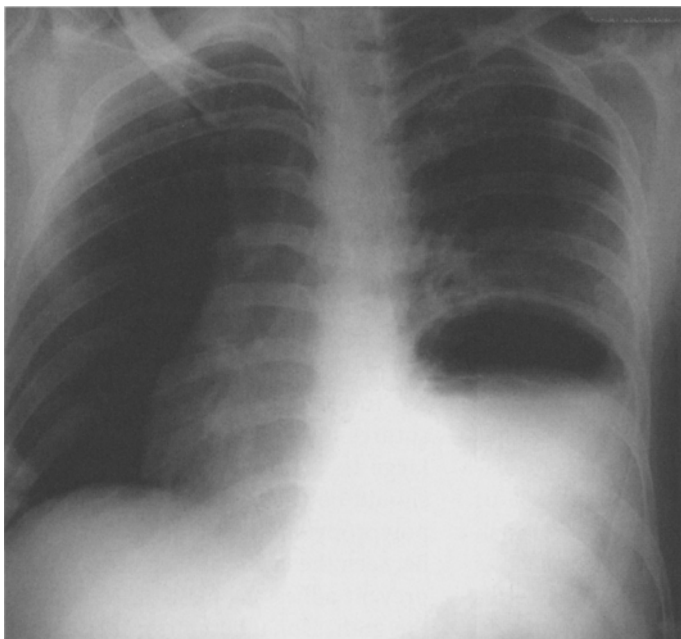


Fig. 1
This patient had a left-sided diaphragmatic hernia in which the stomach herniated through the defect

Table 4. Injury severity scores^a and Abbreviated injury scores^b of the patient groups

	Acute phase (n = 12)	Late-presenting (n = 14)	Total (n = 26)
Age (mean ± standard deviation)	30.1 ± 12	39.2 ± 10.4	35 ± 11
ISS ^a (mean ± standard deviation)	21.2 ± 8.9	9.7 ± 2.4	15 ± 8.7
AIS ^b for diaphragm (mean)	3	3	3

ting patients had a mean ISS of 9.7 ± 2.4 (Table 4). In the acute phase group the mean duration of hospitalisation was 17.2 days for the blunt trauma cases and 6.3 days for penetrating trauma patients. This period was 24.1 days for the late-presenting patients.

Postoperative complications were seen in 9 patients (34.6%). Hydrothorax (n = 4) and wound infection (n = 3) were the most common. Empyema and pneumonia were each observed in one patient. The 2 deaths (7.7%) were in the late-presenting group. One of these patients died from cardiovascular instability, and the other patient from sepsis, subsequent to pneumonia, during the postoperative period. Fifteen of the 26 patients (57.7%) were followed up for a median period of 13 months (1-114 months). There were no recurrent hernias in any of these patients.

Discussion

Signs of diaphragmatic injuries are vague and overt signs usually point to other severe injuries. Traumatic hernias are rare and are sometimes not discovered till many years later [Brown 1985, Symbas 1986]. Diaphragmatic injuries are seen in 4-6% of patients undergoing laparotomy or thoracotomy for trauma [Shah 1995]. Clinically, the diaphragmatic injuries are divided into three phases: the initial or acute phase, latent phase and obstructive phase [Arendrup 1989, Lee 1994, Shah 1995]. We evaluated our patients in two groups: patients diagnosed and treated in the acute phase, and late-presenting patients who were in the latent or obstructive phase.

Penetrating injuries in the upper abdomen and lower thorax call for investigation for possible diaphragmatic injury. In these cases the insult is direct,

and due to the pressure gradient between the abdomen and thorax, the viscera migrate to the thorax. In cases of blunt injury, the pressure generated within the abdominal cavity may cause the tear of the diaphragm. The injury is usually left-sided (70-90%); it is generally accepted that the liver protects the right hemidiaphragm [Brown 1985, Nano 1980, Symbas 1986, Arendrup 1989, Lee 1994, Shah 1995, Payne 1982]. The pressure difference forces the abdominal organs through the defect. This migration is often delayed, probably due to the plugging effect of the viscera over the defect. Consequently, the diaphragmatic injury remains undiagnosed in nearly half of the patients in the acute phase [Arendrup 1989].

In this series the majority of the cases were victims of blunt trauma. They had a mean ISS of 23.6, which is higher than in the patients wounded by penetrating injuries. As ruptures due to blunt trauma generally result from high-energy impacts [Lee 1994, Shah 1995, Payne 1982, Ball 1982], these patients have higher ISS scores [Meyers 1993] and more serious diaphragmatic injuries (higher injury grades) [Ball 1982, Meyers 1993, Payne 1982]. As expected, the ISS for the acutely injured patients were greater than for the late-presenting cases. Interestingly, the diaphragm AIS was the same for both groups, which indicated that neither of the patient groups had a predominant severity of the diaphragm injury (Table 4).

Dyspnea, which was the most common symptom in this series, was not observed as frequently as in other reports [Freixnet 1987]. Decrease in breath sounds was a frequent finding (65.3%). This showed that the physical examination was an important tool for diagnosis, but the pathognomonic finding of bowel sounds in the thorax were auscultated in one-third of our patients.

Chest radiography revealed visceral gas in the thorax in 34.6% of patients, which is diagnostic of diaphragmatic hernia, whereas it was nondiagnostic, but abnormal, in 85% of the cases. The frequency of pathognomonic signs was lower than reported in other reported series but the frequency of the abnormal

findings was higher [Brown 1985, Troop 1985]. In recent studies it has been reported that chest radiographs are 25-30% diagnostic for diaphragmatic hernia at the first admission [Meyers 1993].

Preoperative diagnosis may not be possible because the signs are indefinite and coexisting injuries mask the diaphragmatic injury. A true preoperative diagnosis of diaphragmatic injury was reported in approximately 30-40% of patients [Meyers 1993, Shah 1995]. Introducing a nasogastric tube and inflating the stomach may sometimes help in the diagnosis because the stomach is the most common herniated organ [Arendrup 1989, Shah 1995]. Peritoneal lavage, in addition to detection of other intra-abdominal injuries, may be helpful for diagnosis of diaphragmatic injuries, if used in combination with chest radiography in which the administration of radiocontrast material shows the defect [Troop 1985, Arendrup 1989]. Roentgenographic contrast studies, computerized tomography, ultrasonography, liver-spleen scintigraphy, fluoroscopy and magnetic resonance imaging may help in the diagnosis in some cases [Payne 1982, Ball 1982, Shah 1995, Shackleton 1998]. In recent years laparoscopy has been frequently used for the diagnosis of intra-abdominal injuries, as well as diaphragmatic injuries [Simon 1995]. If laparotomy is undertaken for other causes, both hemidiaphragms must be thoroughly explored to rule out any missed injury [Athassiadi 1999]. The most important factor in the diagnosis is

a high index of suspicion and the proper use of diagnostic studies [Ball 1982].

The most common herniated organ was the stomach in our series. This is in agreement with other reports [Ball 1982, Payne 1982, Brown 1985, Freixinet 1987, Meyers 1993, Lee 1994]. The tendency of stomach to herniate is due to its location in the left upper quadrant.

Multiple coexisting injuries usually occur in diaphragmatic injuries. The most commonly injured organ was the spleen, as was observed in one-fourth of patients in our series. Splenic injury has been reported to occur along with diaphragmatic injury in up to 40% of patients [Troop 1985, Freixinet 1987, Shah 1995, Athassiadi 1999]. The spleen is fragile and relatively fixed to the retroperitoneum by various ligaments. Migration of the spleen due to a pressure gradient or the pulling effect of the stomach, which is the most common herniated organ, results in a tear of the splenic capsule or avulsion of the hilar or short gastric vessels. Other frequent injuries in our patients were rib fractures. This has been reported in up to 40-50% in other studies. Other frequent coexisting injuries reported are liver lacerations and fractures [Meyers 1993, Shah 1995].

In the acute phase, the outcome is primarily determined by associated injuries. The mortality is reported to be around 15-25%. If massive herniation occurs, cardiac and respiratory insufficiency affect the clinical course. In the late-presenting cases, obstruction or

strangulation of the abdominal viscera is the most important complication, and a mortality between 25 to 66% has been reported [Arendrup 1989, Cruz 1994]. Morbidity was also higher in the late-presenting patients and the length of the hospitalization period was highest in this group.

Prompt surgical intervention is the only treatment of diaphragmatic hernias. In emergency cases, laparotomy is the preferred route of entry. It is advised to use interrupted nonabsorbable sutures for primary repair. In cases of large tissue defects, synthetic grafts should be used. When these are used, polypropylene mesh should be placed between the layers of the peritoneum to prevent adhesions between organs and the graft. Nonadherent synthetic grafts are also available. In the late-presenting cases thoracotomy should be kept in mind as the first choice because of the superior exposure and the ease of dissecting the adhesions between the abdominal viscera and thoracic organs [Athassiadi 1999]. If the surgeon encounters any difficulty in dissection or repair, he should not hesitate to make a thoraco-abdominal incision. Although they have not been utilized in this series, laparoscopy and thoracoscopy may be used successfully for both diagnosis and repair [Rasiah 1995, Kurata 1996].

Acknowledgements: We wish to acknowledge the help of Dr. Wayne Criss in preparing the English manuscript of the paper.

References

- Arendrup HC, Arendrup KD (1989) Traumatic diaphragmatic hernia. In: Nyhus LM, Condon RE (eds) *Hernia* 3rd ed. JB Lippincott Company, Philadelphia, pp 708-716
- Athanassiadi K, Kalavrouziotis G, Athanassiou M, Vernikos P, Skrekas G, Poultisidi A, Bellenis (1999) Blunt diaphragmatic rupture. *Eur J Cardiothorac Surg* 15: 469-74
- Ball T, McCrory R, Smith JO, Clements JL (1982) Traumatic diaphragmatic hernia: Errors in diagnosis. *AJR* 138: 633-637
- Brown GL, Richardson JD (1985) Traumatic diaphragmatic hernia: a continuing challenge. *Ann Thorac Surg* 39: 170-173
- Cruz CJ, Minagi H (1994) Large-bowel obstruction resulting from traumatic diaphragmatic hernia: imaging findings in four cases. *AJR* 162: 843-845
- Freixinet JL, Segur JM, Mestres CA, Mateu M, Gimferrer JM, Catalan M, Callejas MA, Letang E, Sanchez-Lloret J (1987) Traumatic injuries of the diaphragm. Experience in 33 cases. *Thorac Cardiovasc Surg* 35: 215-218
- Kurata K, Kubota K, Oosawa H, Eda N, Ishihara T (1996) Thoracoscopic repair of traumatic diaphragmatic rupture. A case report. *Surg Endosc* 10: 850-1
- Lee WC, Chen RJ, Fang JF, Wang CC et al (1994) Rupture of the diaphragm after blunt trauma. *Eur J Surg* 160: 479-483
- Lorimer JW, Reid KR, Raymond F (1994) Blunt extraperitoneal rupture of the right hemidiaphragm: case report. *J Trauma* 36: 414-416
- Meyers BF, McCabe CJ (1993) Traumatic diaphragmatic hernia: Occult marker of serious injury. *Ann Surg* 218 (6): 783-790
- Moore EE, Cogbill TH, Malangoni MA, Jurkovich GJ, Shackford SR, Champion HR, McAninch JW (1995) Organ injury scaling. *Surg Clin N Amer* 75: 293-303
- Nano M, Dei Poli M, Mossetti C, Maggi G (1980) Traumatic diaphragmatic hernias. *Surg Gynecol Obstet* 151: 191-192
- Payne JH, Yellin AE (1982) Traumatic diaphragmatic hernia. *Arch Surg* 117: 18-24
- Rasiah KK, Crowe PJ (1995) Laparoscopic repair of a traumatic diaphragmatic hernia. *J Laparoendosc Surg* 5: 405-7
- Shah R, Sabanathan S, Mearns AJ, Choudhury AK (1995) Traumatic rupture of diaphragm. *Ann Thorac Surg* 60: 1444-1449
- Shackleton KL, Stewart ET, Taylor AJ (1998) Traumatic diaphragmatic injuries: spectrum of radiographic findings. *Radiographics* 18: 49-59
- Shires GT, Thal ER, Jones RJ, Shires GT, Perry MO (1994) Trauma. In: Schwartz SI, Shires GT, Spencer FC, Husser WC (eds) *Principles of Surgery* 6th ed. McGraw-Hill Inc, New York, pp 175-225
- Simon RJ, Ivatury RR (1995) Current concepts in the use of cavity endoscopy in the evaluation and treatment of blunt and penetrating truncal injuries *Surg Clin N Amer* 75: 157-174
- Symbas PN, Vlasis SE, Hatcher C (1986) Blunt and penetrating diaphragmatic injuries with or without herniation of organs into the chest. *Ann Thorac Surg* 42: 158-162
- Troop B, Myers RM, Agarwal NN (1985) Early recognition of diaphragmatic injuries from blunt trauma. *Ann Emerg Med* 14: 97-101