ORIGINAL ARTICLES

Traumatic Rupture of the Diaphragm

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OBJECTIVE: Traumatic rupture of the diaphragm (TRD) is a rare occurrence, with variable morbidity and mortality. The aim of this study was to analyze cases of TRD in a tertiary hospital and assess prognostic factors associated with mortality.

PATIENTS AND METHODS: A retrospective study was performed of patients diagnosed with TRD in Hospital Universitario La Fe, Valencia, Spain, between 1969 and 2006. The following variables were analyzed: sex, age, cause, diagnosis, associated lesions, surgical procedure, side and size of the lesion, visceral herniation, and postoperative morbidity and mortality.

RESULTS: The study group comprised 132 patients (105 men, 79.5%) with a mean (SD) age of 39.64 (17.04) years. Traffic accidents were the most common cause of TRD. Rupture involved the left hemidiaphragm in 96 cases (72.7%), and 113 patients (85.6%) had associated lesions, most often affecting the abdomen. Thoracotomy was performed in 83 cases (62.9%) and laparotomy in 41 (31.1%). Visceral herniation was reported in 90 patients (68.3%), most often involving the stomach.

The rates of perioperative morbidity and mortality were 62.8% and 20.5%, respectively. Diagnostic delay and the presence of morbidity and serious associated lesions all had a statistically significant impact on mortality ($P<.05$). In the case of serious associated lesions, the odds ratio was 2.898 (95% confidence interval, 1.018-8.250) and for perioperative morbidity it was 1.488 (95% confidence interval, 1.231-1.798).

CONCLUSIONS: TRD is an infrequent occurrence in young men, is generally caused by traffic accidents, and is more common on the left side. Associated lesions are present in most cases and represent the main prognostic factor affecting morbidity and mortality. TRD can be considered a relative surgical emergency when not accompanied by other lesions that in themselves constitute surgical emergencies.

Key words: *Rupture. Diaphragm. Injury. Surgery. Outcomes. Survival. Morbidity. Mortality.*

Rotura diafragmática traumática

OBJETIVO: La rotura diafragmática traumática (RDT) es una lesión infrecuente, con tasas variables de morbimortalidad. El objetivo del estudio ha sido analizar la experiencia en RDT de un hospital terciario y los factores pronósticos de mortalidad.

PACIENTES Y MÉTODOS: Se ha realizado un estudio analítico y retrospectivo de los pacientes diagnosticados de RDT entre 1969 y 2006 en el Hospital La Fe. Se analizaron: sexo, edad, causa, diagnóstico, lesiones asociadas, procedimiento quirúrgico, lado y tamaño, herniación visceral y morbimortalidad postoperatoria.

RESULTADOS: Se incluyó en el estudio a 132 pacientes (105 varones; 79,5%) con una edad media ± desviación estándar de 39,64 ± 17,04 años. Los accidentes de tráfico fueron la causa más frecuente de RDT. En 96 casos (72,7%) se afectó el hemidiafragma izquierdo y 113 pacientes (85,6%) asociaron lesiones, de las cuales las abdominales fueron las más frecuentes. Se abordaron por toracotomía 83 casos (62,9%) y por laparotomía 41 (31,1%). En 90 pacientes (68,3%) se evidenció herniación visceral, siendo el estómago la más frecuente.

Las tasas de morbilidad y mortalidad perioperatorias fueron del 62,8 y el 20,5%, respectivamente. La presencia de morbilidad y de lesiones asociadas graves, y el retraso diagnóstico tuvieron un impacto significativo en la mortalidad ($p < 0,05$. Lesiones graves: *odds ratio* = 2,898; intervalo de confianza del 95%, 1,018-8,250. Morbilidad perioperatoria: *odds ratio* = 1,488; intervalo de confianza del 95%, 1,231-1,798).

CONCLUSIONES: La RDT es una entidad infrecuente que se da en varones jóvenes, generalmente por accidentes de tráfico, y es más frecuente en el lado izquierdo. Las lesiones asociadas están presentes en la mayoría de los casos y son el principal factor pronóstico que condiciona la morbimortalidad. La RDT puede considerarse una urgencia quirúrgica diferida, en ausencia de otras lesiones que constituyan una urgencia quirúrgica en sí mismas.

Palabras clave: *Rotura. Diafragma. Traumatismo. Cirugía. Resultados. Supervivencia. Morbilidad. Mortalidad.*

Introduction

Traumatic rupture of the diaphragm (TRD) has been recognized since 1541, when it was first described by Sennertus.[1] It is an infrequent, although not rare, injury that occurs in between 0.8% and 7% of blunt traumas and between 10% and 15% of penetrating traumas involving the chest or abdomen.[2,3] A study carried out in Spain observed a frequency of around 2.35% in blunt chest trauma.[4]

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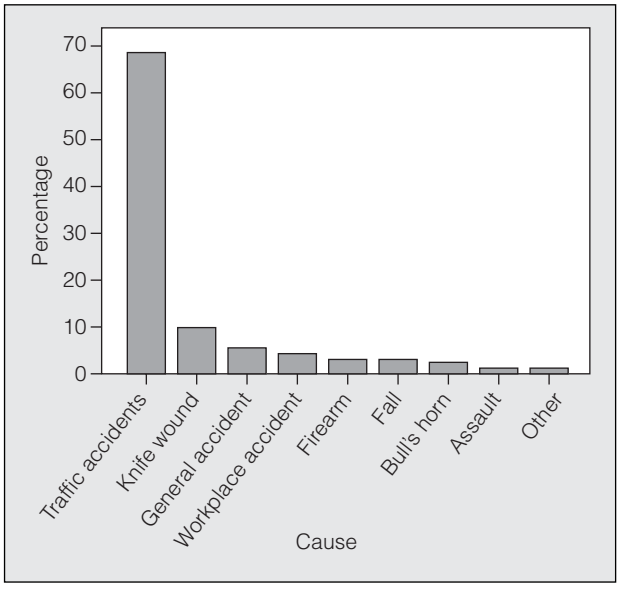

Figure 1. Causes of trauma leading to rupture of the diaphragm.

Various mechanisms have been proposed to explain how this injury occurs, but none are fully accepted. Desforges et al[5] postulated that TRD is the result of a force that when applied to the abdomen or flank and transmitted via the abdominal viscera, impinges upon the diaphragm. Bekassy et al[6] studied the effect of pressure on diaphragms taken from cadavers and observed a relative weakness of the left leaf. It is therefore not surprising that all studies concur in observing a higher frequency of TRD on the left side.

Diagnosis of TRD continues to be imprecise and delays are not uncommon, since reliable diagnostic tests, particularly for use in acute situations, are unavailable. In fact, in around 25% of cases diagnosis is made during surgery.[7] Proposed diagnostic methods range from simple chest radiography to magnetic resonance imaging, and include computed tomography (CT), liver or spleen scintigraphy, and contrast studies using gastrografin or barium.[8-11]

Most authors consider confirmed TRD a surgical emergency that should therefore be treated immediately.[12] However, some others suggest that surgical treatment may be postponed in the absence of other lesions that of themselves represent surgical emergencies.[13,14] This delay would allow examination of the patient to be completed without worsening prognosis.

TRD has been considered an indicator of severity in chest and abdominal trauma[7] and is associated with other injuries in almost all cases.[15] The reported mortality ranges from 1% to 42% depending on the study.[7] In their 1995 review, Shah et al[16] established a mean mortality of 17%.

The aim of this study was to analyze cases of TRD in a tertiary referral hospital and to identify factors that influence patient prognosis.

Patients and Methods

A retrospective observational study of patients admitted to Hospital Universitario La Fe in Valencia, Spain, between 1969 and 2006 was performed. Data from general hospital records and from the records of the Thoracic Surgery Department were reviewed. Patients were included if they had a diagnosis of TRD according to the International Classification of Diseases, Ninth Revision[17] (codes 862.0 and 862.1). Patients were excluded if they had lesions of the diaphragm not caused by trauma or if the diagnosis of TRD could not be confirmed.

The following variables were analyzed: sex, age, symptoms, etiology, diagnostic method, associated lesions, surgical approach and procedure, side and size of the rupture, visceral herniation, delay in diagnosis and treatment, postoperative morbidity and mortality, and diaphragmatic sequelae. Mortality was calculated using only deaths related to TRD or the consequences of the trauma. Other causes of death were excluded. For the analysis of factors influencing mortality, associated lesions were classified as severe (at least 2 of the following: severe head trauma, severe abdominal trauma, injury to the spinal column and legs, and severe thoracic lesions) and not severe.

Statistical Analysis

Statistical analysis was done with SPSS software. Quantitative variables were compared by *t* test and qualitative variables by χ^2 test or Fisher exact test when necessary. The odds ratio and 95% confidence interval (CI) were calculated by logistic regression in the case of qualitative variables and linear regression for quantitative ones. A value of $P \leq .05$ was considered statistically significant.

Results

The study group comprised 132 patients with confirmed TRD: 105 men (79.5%) and 27 women (20.5%) with a mean (SD) age of 39.64 (17.04) years (range, 10-89 years).

TABLE 1
Presenting Symptoms and Diagnostic Methods in Rupture of the Thoracic Diaphragm

Variable	No.	%
Symptoms		
Multiple trauma	87	65.9
Thoracic or abdominal trauma	18	13.7
Dyspnea	12	9.1
Epigastralgia	4	3.0
Subocclusion	4	3.0
Wall hernia	2	1.5
Hemoptysis	2	1.5
Nonspecific	1	0.8
Diagnostic technique		
Simple chest radiograph	55	41.7
Computed tomography	17	12.9
Laparotomy	31	23.5
Thoracotomy	12	9.1
Transit[a]	9	6.8
Pneumoperitoneum	5	3.8
Thoracoscopy	2	1.5
Ultrasound	1	0.8
Preoperative diagnosis		
Yes	87	65.9
No	45	34.1

[a]Radiologic contrast study of the upper gastrointestinal tract.

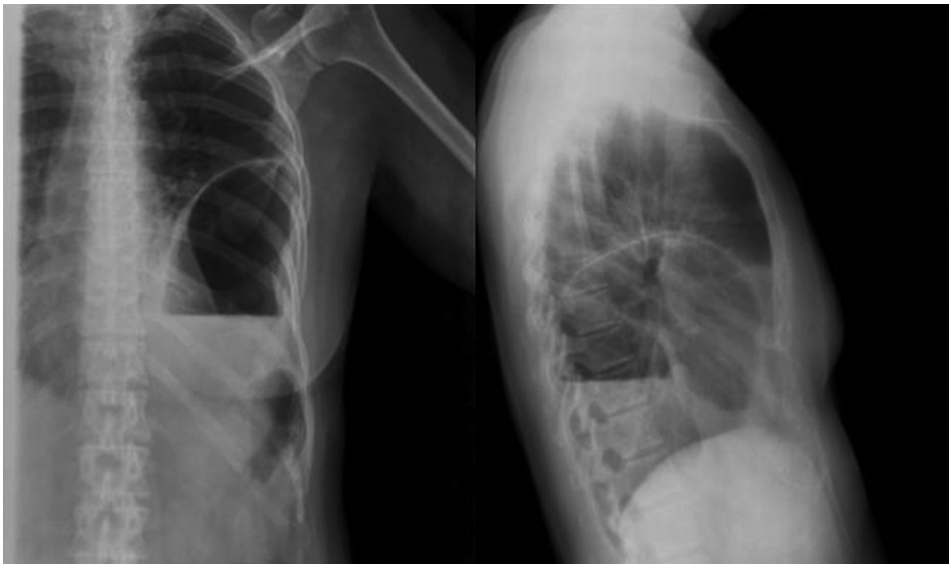

Figure 2. Simple chest radiograph (posteroanterior and lateral) of acute traumatic rupture of the diaphragm diagnosed 15 hours after the injury occurred.

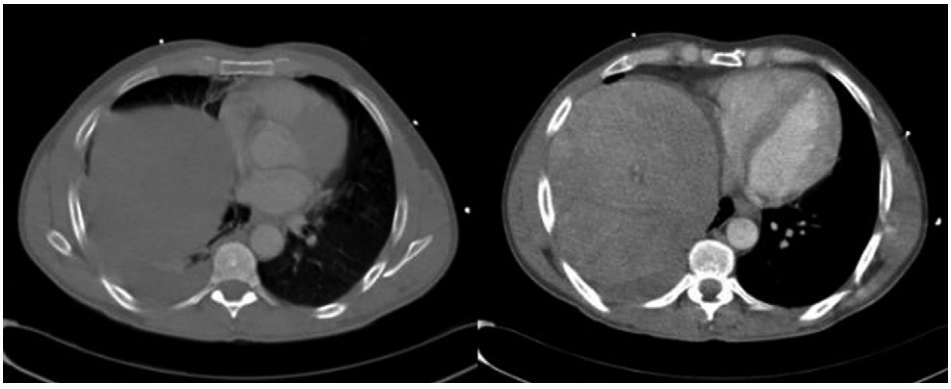

Figure 3. Computed tomography scan of the thorax, with and without iodinated contrast, showing elevation of the liver into the right hemithorax. In this case, diagnosis was confirmed by thoracoscopy prior to thoracotomy.

In 116 patients (87.9%) there was no relevant medical history.

Figure 1 shows the causes of TRD and Table 1 shows the presenting symptoms and the diagnostic method used. Figures 2 and 3 illustrate the contribution of different radiologic methods in the diagnosis of TRD. Twenty patients had penetrating trauma and 112 (84.8%) blunt trauma. Diagnosis was obtained prior to surgery in 65.9% of cases. In 78 patients (60.5%), diagnosis was obtained in the first 24 hours following trauma, while in the remaining 54 (39.5%) there was further delay. The median delay was 17 days (range, 1 day to 40 years). In 113 patients (85.6%), TRD was associated with lesions outside the thorax and in 91 (68.5%) there were lesions affecting the thorax. Associated lesions are shown in Table 2.

Eight patients did not receive surgical treatment: 4 were dead on arrival at hospital as a consequence of irreversible hypovolemic shock; 2 patients in whom diagnosis was delayed and who were in a clinically stable condition were referred back to their own health care services; in 1 patient a wait and see approach was taken; and in another patient there was no record of whether or not surgery had been performed. Of those patients who were treated surgically (n=124), TRD was repaired with thoracotomy in 83 (62.9%) and with laparotomy in 41 (31.1%). In 96 patients (72.7%), TRD was on the left side, in 35 (26.5%) it was on the right, and in 1 (0.8%) it was bilateral.

In 119 patients (90.2%), the use of simple interrupted sutures was sufficient to repair the diaphragm. In 3 cases

TABLE 2
Associated Lesions

Lesion	No.	%[a]
Thoracic		
No lesion	41	31.5
Pneumothorax	13	9.8
Pleural effusion	33	25.0
Rib fractures	56	42.4
Pulmonary laceration-contusion	15	11.3
Penetrating wound	9	6.8
Total	167	
Nonthoracic		
Head trauma	36	27.2
Abdomen	81	61.3
Spine	26	19.7
Pelvis	14	10.6
Limbs	42	31.8
Total	199	
Multiple/severe	60	45.5
Multiple	31	23.5

[a]Percentages calculated according to the total number of patients (n=132).

TABLE 3
Visceral Herniation

	Penetrating Trauma	Blunt Trauma	Total	*P*
Herniation, yes/no	6/14	84/28	90/42	.0001
Organ				
Stomach	3	55	58	<.01
Spleen	1	25	26	<.01
Colon	2	20	22	<.01
Liver	0	21	21	<.01
Small intestine	1	1	2	NS

Abbreviation: NS, not significant.

a prosthesis was required; in 2 cases a synthetic prosthesis was used and in the third, from the early years of the study period, the dura mater was used. In 2 cases, suturing to the chest wall was performed due to detachment of the diaphragm. The mean size of rupture was 12.5 (5.6) cm (range, 1-20 cm). Surgery was performed within the first 24 hours following trauma in 67 patients (50.8%). In 57 patients (43.1%) the intervention was delayed for a median of 16.5 days (range, 1 day to 40 years). A total of 39 patients required splenectomy for irreparable lesions of the spleen.

Surgery had to be repeated in 4 patients: 2 for recurrence of diaphragmatic hernia, 1 for dehiscence of the thoracotomy, and 1 for empyema. In 90 patients (68.3%), visceral herniation through the diaphragm defect was observed. Table 3 shows the organs that were herniated into the thorax, classified according to whether the trauma was blunt or penetrating.

Following surgery, 111 patients (84.1%) spent at least 24 hours in the surgical intensive care unit. Complications occurred in 83 patients, corresponding to a perioperative morbidity of 62.8%. Twenty-seven patients (20.5%) died as a direct consequence of trauma or its immediate complications. The most common complications and causes of death are described in Table 4.

Analysis of prognostic factors in these patients revealed that the presence of morbidity, severe associated lesions, and diagnostic delay were the only variables that had statistically significant effects on mortality. The results of univariate analysis are shown in Table 5. The logistic regression analysis showed that the presence of severe associated lesions and perioperative morbidity had a significant influence on perioperative mortality (*P*=.046 and *P*=.0001, respectively). The following regression equation was established:

$$\text{Mortality} = (-3.406) + (1.064 \times \text{severe lesions}) + (0.397 \times \text{perioperative morbidity}).$$

Table 6 shows the results of the logistic regression analysis.

When the results of diaphragm repair were assessed a year later, sequelae were absent in 58 patients (43.9%). In 9 patients (6.8%), there was an elevation of the diaphragm with some degree of paresis, and in 14 (10.6%) there was pleural thickening. In 51 patients (38.7%) the results of repair could not be assessed due to either death of the

TABLE 4
Complications and Causes of Death

Morbidity	No.	%[a]
No morbidity	49	37.1
Atelectasis	28	21.2
Pleural effusion	25	18.9
Pneumonia	16	12.1
Acute respiratory distress syndrome	4	3.0
Nausea and vomiting	6	4.5
Neurologic complications[b]	6	4.5
Gastrointestinal fistula	2	1.5
Wound infection	2	1.5
Biliothorax	1	0.7
Total	90	
Causes of Death	**No.**	**%**
Surviving	105	79.5
Septic shock	7	5.3
Hypovolemic shock	6	5.3
Respiratory failure	4	3.0
Head trauma	5	3.8
Multiorgan failure	3	2.3
Traumatic aortic dissection	1	0.8
Aggravation of existing disease	1	0.8
Total	27	

[a]Percentages calculated according to the total number of patients (n=132). [b]Such as residual hemiparesis.

TABLE 5
Analysis of Prognostic Factors Associated With Mortality[a]

Variable	Surviving	Dead	*P*
Morbidity, yes/no	60/45	24/3	.002
Severe lesions, yes/no	64/41	19/8	.004
Diagnostic delay	576.04 (193.62)	110.74 (79.25)	.026
Age, y	38.64 (16.66)	43.41 (18.25)	.19
Sex, M/F	84/21	21/6	.79
Surgical delay,	473.61 (182.61)	125.75 (88.89)	.36
Side, left/right	73/31	23/4	.25
Approach, thoracotomy/ laparotomy	66/34	17/7	.42
Visceral herniation, yes/no	71/34	19/8	.78
Trauma, penetrating/blunt	16/89	4/23	.61
Splenectomy, yes/no	28/77	11/16	.15
Diagnosis, preoperative/ intraoperative	68/37	19/8	.58

Abbreviations: M, male; F, female.
[a]Data are shown as number of patients or means (SD).

TABLE 6
Estimated Risk of Death

Variable	B	*P*	OR	95% CI
Severe lesions	1.064	.046	2.898	1.018-8.250
Perioperative morbidity	0.397	.001	1.488	1.231-1.798
Constant	–3.406			

Severe lesions: no=0, yes=1. Perioperative morbidity: no=0, yes=1.
Abbreviations: CI, confidence interval; OR, odds ratio.

patient or the absence of radiographs obtained during follow-up.

Discussion

TRD is an uncommon entity, with an incidence of 0.8% to 7% in blunt traumas and 10% to 15% in penetrating traumas of the chest and abdomen.[2,3] This relative rarity, although not quantified in this study, is reflected in the identification of only 132 confirmed cases over a period of 40 years in a tertiary referral hospital with a large number of patients admitted for multiple trauma or trauma of the chest or abdomen.

Many studies agree that it is more common in young men, on the left side, and as a consequence of blunt trauma of the chest or abdomen.[7,9,13,14,16,18,19] Our study confirms these observations. In terms of the causes, we also find that it is most often due to traffic accidents, followed by knife and bullet wounds.[16,19] As a result of a Spanish cultural idiosyncrasy, injuries caused by bull's horns account for 2.3% of cases of TRD, a finding which is not obtained in studies outside of Spain.

Early diagnosis of TRD continues to be a challenge both for radiologists and for surgeons, and most authors agree on the need to maintain a high level of suspicion in order to diagnose this lesion.[14,16,18,19] This difficulty in obtaining a diagnosis is reflected in the failure to reach desirable levels of preoperative diagnosis of TRD, which under ideal conditions would be close to 100%. Athanassiadi et al[14] and Haciibrahimoglu et al[18] reported preoperative diagnosis rates of 72.2% and 88.8%, respectively, and the review published by Shah et al[16] in 1995 reported rates of between 3.9% and 68%. In our study, preoperative diagnosis was obtained in 87 patients (65.9%).

Chest radiography, peritoneal lavage, diagnostic pneumoperitoneum, fluoroscopy, gastrointestinal contrast studies, ultrasound, CT scans, magnetic resonance imaging, and liver and spleen scintigraphy are the methods generally used for the diagnosis of TRD.[8-10,14,16,18,19] However, none of them in isolation has a high sensitivity or specificity, and there is currently no gold-standard diagnostic test. Nevertheless, chest radiography continues to be a useful tool for the diagnosis of TRD, with a diagnostic yield of between 27% and 60%,[10] and it must be performed in all patients with chest or abdominal trauma (Figure 2). In our study, the technique was diagnostic in 41.7% of patients, a rate which is consistent with the 40.7% observed in the review published by Shah et al.[16] CT is another useful tool for the diagnosis of this lesion, with a sensitivity of 14% to 61% and a specificity of 76% to 99%, which increase to 71% and 100%, respectively, when helical CT is used.[10] In our study, the first case of TRD diagnosed by CT was identified in 1986, and the method has confirmed TRD in 13% of all cases (Figure 3). Since its introduction, CT has become the main method used for the diagnosis of TRD in our hospital, accounting for 26.6% of the 64 cases confirmed in that period, compared with 21.9% of cases in which diagnosis was established by radiography.

Thoracoscopy, first used in 1993, represents a useful diagnostic tool for use in TRD[20] and has a sensitivity, specificity, and positive predictive value of 100%.[21] In our department, this technique has recently been incorporated into the diagnostic toolbox for use in chest trauma, and in recent years diagnostic confirmation has been obtained by thoracoscopy prior to thoracotomy in 2 cases of right-sided TRD. Some authors have also reported good results with the use of thoracoscopy for repair of the diaphragm defect.[22,23] To date, however, endoscopic repair of the diaphragm has not been performed in our hospital.

Various classifications have been proposed for the natural history and diagnostic phases of TRD. Grimes[24] divided the presentation into 3 phases: *a)* the acute phase, which encompasses the period from the trauma to recovery from the primary lesions and is usually dominated by the presence of associated lesions other than TRD; *b)* the latent phase, which is related to visceral herniation into the thorax and is usually manifested by chest or abdominal pain and gastrointestinal symptoms; and *c)* the obstructive phase, characterized by signs of obstruction or ischemia of the viscera trapped in the diaphragm defect.[16] Of the patients included in our study, 82.6% were diagnosed in the acute phase, 11.4% in the latent phase, and 6.1% in the obstructive phase.

The position of the diaphragm, as a natural boundary between the abdominal and thoracic cavities, implies a close association with the viscera that surround it. This is reflected in the frequent association of diaphragm lesions with abdominal and thoracic lesions. In addition, the mechanism by which these lesions are generated, generally high-energy trauma, also explains the frequent association with more distant lesions such as head trauma and fractures of the pelvis and limbs. Some authors have reported associated lesions in almost 100% of cases.[14,16] In our experience, 85.6% of the patients had associated lesions in addition to TRD, the most common being abdominal lesions (61.3%)—particularly affecting the spleen and liver—and thoracic lesions, with rib fractures in 42.4% of cases and pleural effusions in 25%. The high percentage of patients with visceral herniation into the thorax (68.3%) also reflects the close association between the diaphragm and the abdominal viscera. Another less common, but no less important, group comprises head trauma and fractures of the pelvis and limbs, affecting 27.2% and 42.4% of patients, respectively. The importance of this element is such that some authors have been able to establish a system to predict the presence of TRD from the associated lesions. In 2002, Reiff et al[13] published a study of 397 182 victims of traffic accidents, including 8397 patients with TRD. In that study, a traffic accident with vehicle compartment intrusion of at least 30 cm or a speed of at least 40 km/h, associated with lesions of the spleen or pelvic fracture, was associated with a sensitivity of more than 85% for detection of TRD. In our study, we also found a large number of splenic lesions, which led to 39 splenectomies.

As a result of the difficulty in diagnosing TRD and the presence of severe associated lesions that are the initial focus of attention, in an appreciable number of cases diagnosis of the diaphragm lesion is delayed and there is a high rate of intraoperative diagnoses and even lesions that pass unnoticed despite surgery. This has been the source of some debate, particularly regarding the impact

of this diagnostic and therapeutic delay on patient prognosis. Spann et al[21] reported that delayed diagnosis of TRD is associated with an increase in morbidity and mortality of patients and that it should be considered a surgical emergency in its own right. At the other extreme, authors such as Bergeron et al[7] argue that, in the absence of other surgical emergencies, repair of the diaphragm can be delayed without any appreciable increase in mortality. In our experience, there were significant differences in diagnostic delay between patients who died and those who survived, but contrary to what might be expected. The diagnostic delay in patients who died was significantly shorter (110.74 [79.25] days) than in surviving patients (580.55 [193.62] days). This finding may be explained by the higher frequency of severe associated lesions in patients who died (Table 6); this would have led to more exhaustive diagnostic studies and a higher rate of urgent surgical interventions, factors which would have increased the probability of earlier diagnosis of TRD. In the group of survivors, the diagnostic delay was approximately 3.5 months longer than the delay in intervention. This apparently impossible finding is explained by the presence of patients with delayed diagnosis in whom the intervention was not performed for various reasons.

There were no significant differences in surgical delay between patients who survived and those who died. Therefore, in our opinion repair of TRD can be postponed without significant worsening of patient prognosis, so long as there are no other indications for urgent surgery. TRD could therefore be considered a relative surgical emergency that allows for stabilization of the patient—for instance, those with cranial or pulmonary lesions—and for completion of imaging studies prior to surgery to repair the diaphragm.

Repair of TRD can be approached by either thoracotomy or laparotomy, with certain considerations. Laparotomy must be performed in patients with associated abdominal lesions or hemodynamic instability.[7] This approach allows repair of the left side without significant difficulties. On the right side, the liver can hinder repair, and additional thoracotomy may be necessary. In chronic cases, and those in which the intervention has been delayed, the approach of choice is thoracotomy.[16,18]

The reported rates of perioperative morbidity vary between 11% and 53.3%, and pulmonary complications are the most common.[14,16,18,19] In our series the rate of postoperative complications was 62.9% and pulmonary problems headed the list of complications (Table 4). The mortality rates published in the literature range from 1% to 42%,[7,14,16,18] and are invariably due to associated lesions. In our patients the mortality rate was 20.5%. As shown in Table 4, the most frequent causes of death were septic shock and hemorrhagic shock. Severe associated lesions and the development of perioperative morbidity are primary prognostic factors in patients with TRD, with odds ratios of 2.898 (95% CI, 1.018-8.250) and 1.488 (95% CI, 1.231-1.798), respectively.

The outcomes of diaphragm repair are generally good. Complete recovery was achieved in 43.9% of cases, and in those cases in which some type of sequela remained, there was no significant impairment of breathing or quality of life.

In conclusion, TRD is an infrequent event that generally occurs in young men, mainly as a consequence of blunt trauma due to traffic accidents and tending to favor the left side. It represents a diagnostic challenge and a high level of suspicion is required in order to establish a diagnosis. Chest radiographs and CT scans offer acceptable results, although in a third of cases the diagnosis is made during surgery. This diagnostic difficulty associated with TRD results in a large number of delayed diagnoses, without any apparent effect on patient prognosis. Associated lesions are present in most cases and represent the main prognostic factor affecting morbidity and mortality, which is around 20%. Thoracic and splenic lesions are the most common, and the most frequent complications involve the lungs.

TRD can be considered a relative surgical emergency that, when not accompanied by other lesions that of themselves constitute surgical emergencies, allows some delay in treatment while the patient is stabilized. Laparotomy is the approach of choice for acute treatment in the presence of abdominal lesions or hemodynamic instability, while thoracotomy is the most appropriate in chronic or delayed cases and when the injury affects the right side, leading to difficulties with an abdominal approach.

REFERENCES

1. Schneider C. Traumatic diaphragmatic hernia. Am J Surg. 1956; 91:290-4.
2. Meyers B, McCabe C. Traumatic diaphragmatic hernia: occult marker of serious injury. Ann Surg. 1993;218:783-90.
3. Boulanger BR, Milzman DP, Rosati C, Rodríguez A. A comparison of right and left blunt traumatic diaphragmatic rupture. J Trauma. 1993;35:255-60.
4. Galán G, Peñalver JC, Paris F, Caffarena JM Jr, Blasco E, Borro JM, et al. Blunt chest injuries in 1696 patients. Eur J Cardiothorac Surg. 1992;6:284-7.
5. Desforges G, Strieder J, Lynch J, Madoff I. Traumatic rupture of the diaphragm; clinical manifestations and surgical treatment. J Thorac Surg. 1957;34:779-97.
6. Bekassy S, Dave K, Wooler G, Ionescu M. Spontaneous and traumatic rupture of the diaphragm: long term results. Ann Surg. 1973;177:320-4.
7. Bergeron E, Clas D, Ratte S, Beauchamp G, Denis R, Evans D, et al. Impact of deferred treatment of blunt diaphragmatic rupture: a 15 year experience in six trauma centers in Quebec. J Trauma. 2002;52:633-40.
8. Bergin D, Ennis R, Keogh C, Fenlon HM, Murray JG. The "dependent viscera" sign in CT diagnosis of blunt traumatic diaphragmatic rupture. AJR Am J Roentgenol. 2001;177:1137-40.
9. Nau T, Seitz H, Mousavi M, Vecsei V. The diagnostic dilemma of traumatic rupture of the diaphragm. Surg Endosc. 2001;15:992-6.
10. Iochum S, Ludig T, Walter F, Sebbag H, Grosdidier G, Blum AG. Imaging of diaphragmatic injury: a diagnostic challenge? Radiographics. 2002;22 Suppl:103-16.
11. Nchimi A, Szapiro D, Ghaye B, Willems V, Khamis J, Haquet L, et al. Helical CT of blunt diaphragmatic rupture. AJR Am J Roentgenol. 2005;184:24-30.
12. Asensio J, Demetriades D, Rodríguez A. Injury to the diaphragm. In: Moore KL, Feliciano DV, Moore EE, editors. Trauma. 4th ed. New York: McGraw-Hill; 2000. p. 603-32.
13. Reiff DA, McGwin GJ, Metzger J, Windham ST, Doss M, Rue LW III. Identifying injuries and motor vehicle collision characteristics that together are suggestive of diaphragmatic rupture. J Trauma. 2002;53:1139-45.
14. Athanassiadi K, Kalavrouziotis G, Athanassiou M, Vernikos P, Skrekas G, Poultsidi A, et al. Blunt diaphragmatic rupture. Eur J Cardiothorac Surg. 1999;15:469-74.

15. Arak T, Solheim K, Pillgram-Larsen J. Diaphragmatic injuries. Injury. 1997;28:113-7.
16. Shah R, Sabanathan S, Mearns AJ, Choudhury AK. Traumatic rupture of diaphragm. Ann Thorac Surg. 1995;60:1444-9.
17. Ministerio de Sanidad y Consumo. Clasificación internacional de enfermedades. 9.ª revisión. Modificación Clínica. Madrid: Ministerio de Sanidad y Consumo; 2006.
18. Haciibrahimoglu G, Solak O, Olcmen A, Bedirhan MA, Solmazer N, Gurses A. Management of traumatic diaphragmatic rupture. Surg Today. 2004;34:111-4.
19. Milhos P, Potaris K, Gakidis J, Paraskepoulos J, Varvatsoulis P, Gougoutas B, et al. Traumatic rupture of the diaphragm: experience with 65 patients. Injury. 2003;34:169-72.
20. Mealy K, Murphy M, Broe P. Diagnosis of traumatic rupture of the right hemidiaphragm by thoracoscopy. Br J Surg. 1993;80:210-1.
21. Spann JC, Nwariaku FE, Wait M. Evaluation of video-assisted thoracoscopic surgery in the diagnosis of diaphragmatic injuries. Am J Surg. 1995;170:628-30.
22. Koehler RH, Smith RS. Thoracoscopic repair of missed diaphragmatic injury in penetrating trauma: case report. J Trauma. 1994;36:424-7.
23. Kurata K, Kubota K, Oosawa H, Eda N, Ishihara T. Thoracoscopic repair of traumatic diaphragmatic rupture. A case report. Surg Endosc. 1996;10:850-1.
24. Grimes O. Traumatic injuries of the diaphragm. Am J Surg. 1974; 128:175-81.