

An easily overlooked cause of mortality in trauma: rupture of diaphragm



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BACKGROUND: The purpose of our study was to share our experience in patients with traumatic diaphragmatic rupture.

METHODS: Patients underwent surgery for traumatic diaphragm rupture between 2005 and 2010 were reviewed.

RESULTS: There were sixty-two patients with traumatic diaphragm rupture. The mean age of the study group was 28.7 years (range 15-62 years). Diaphragmatic rupture was left sided in 43 patients (69%), right sided in 17 (28%) and bilateral in 2 (3%). Thoracotomy applied in 8 patients, laparotomy in 50, thoracoabdominal approach in 4. Mortality seen at 4 (6.4%) patients and hemorrhagic shock was the reason in two and pneumonia and sepsis in two.

CONCLUSIONS: Diaphragm ruptures are infrequent injuries, however, are easily overlooked due to mask effect of accompanying visceral injuries, and it should be kept in mind at lower thoracic or upper abdominal traumas to prompt and proper management to lower the risk of mortality.

KEY WORDS: Diaphragm rupture, Thoracoabdominal trauma, Treatment

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Introduction

Diaphragm has tendon and muscle parts and act as an anatomical barrier to separate abdominal and thoracic cavities¹. Traumatic diaphragm rupture (TDR) was first

defined by Sennertus in 1541. Bowditch made ante-mortem diagnosis of TDR in 1853. The first large series on TDR was published in 1951 and these studies are the cornerstones of treatment until now²⁻⁴. TDR is a clinical condition can be faced in severe trauma and considered as an indicator for the severity of trauma³. Etiology include blunt trauma, penetrating trauma, and iatrogenic injury^{5,6}. While TDR is encountered in 1-7% of major blunt traumas, it is seen 10-15% of penetrating lower chest traumas^{3,7,8}. It is sometimes difficult to make diagnosis, however, suspicion is an important step. In patients treated conservatively, diagnosis might be overlooked even during the surgical operation at 12-66%³. Delay in diagnosis may increase mortality and morbidity regarding likely accompanying organ injuries^{8,12}.

It is anyways important to remember that sometimes a former diaphragmatic post traumatic injury may remain

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unknown for a long time, giving rise to a late discovery for subsequent complications⁹⁻¹¹.

The aim of our study is to determine factors effecting mortality and morbidity in patients with diaphragmatic rupture secondary to blunt and penetrating thoracoabdominal injuries.

Patients and Methods

Records of patients admitted to the emergency department of University of Dicle, between January 2005 and December 2010 were retrospectively searched and 62 patients with TDR were entered in the study. Of the patients, age, gender, way of trauma, time to diagnosis, diagnostic methods, accompanying organ injury, area of diaphragm damaged, form of repair of diaphragmatic rupture, duration of hospital stay, trauma severity score (ISS), and morbidity and mortality rates were analyzed. At our institution, chest x-ray is the first step in patients with suspected diaphragm rupture and in uncertain cases computed tomography (CT) is chosen for confirmation. Furthermore, CT serves detection of accompanying organ injuries. As a policy of our department, those with suspicion of isolated lung injury and hemopneumothorax were underwent thoracotomy, those with suspicion of solely intraabdominal injury underwent laparotomy and those with suspicion of both lung and intraabdominal injury were underwent thoracotomy plus laparotomy. Primary repair with non-absorbable sutures applied patients with diaphragm defect less than 10 cm in diameter whereas synthetic graft was preferred in patients with tissue loss and defect of more than 10 cm in diameter. In general, patient with diaphragmatic rupture were graded according the AAST (American Association for the Surgery of Trauma) classification, which was reported in the name of the Organ Injury Scaling Group by Moore et al.¹³. Trauma severity score was calculated after determination of accompanying organ injuries. There were four mortalities and factors having effect on mortality were searched in the patient population.

Statistical analysis: continuous variables were compared using the unpaired Student's *t*-test and differences between categorical variables were assessed using the Mann-Whitney U test. A *P*-value of <0.05 was considered statistically significant.

Results

Of the patients, 54 were male (87%) and 8 were female (13%), and the mean age of the study group was 28.7 (range 15-62). The mean hospital stay was 13.8 (range 1 to 57) days. Sorts of injury included firearms (n. 31, 50%), penetrating instruments (knife, skewer, etc.) (n. 22, 35%), traffic accident (n: 7, 11%) and fall downs (n. 2, 3%). Diaphragmatic rupture was left sided in 43

(69%) patients, right sided in 17 (28%), and bilateral in 2 (3%) patients. Rupture was left sided in 61% (19/31) of patients with firearm injury whereas 68% (15/22) of patients with penetrating injury. Moreover, all blunt traumas were left sided (Table I).

TDR was diagnosed within first 24 hours of injury in 58 (94%) patients while in 48 and 72 hours in 2 patients and in one and seven years in 2 patients. Twenty-seven patients were diagnosed preoperatively (43%) and 35 (57%) intraoperatively. Diagnostic peritoneal lavage carried out in 54 patients with suspected intraabdominal hemorrhage and was positive in 43 (80%) patients. Of the patients, 50 (80.6%) had accompanying organ injury (Table II).

TABLE I - Diaphragmatic rupture sides regarding trauma cause

	N	Ruptured side		
		Right	Left	Bilateral
Traffic accident	7	0	7	0
Fall down injury	2	0	2	0
Firearm injury	31	11	19	1
Penetrating injury	22	6	15	1
Total	62	17	43	2

TABLE II - Concomitant injuries in patients with diaphragm rupture.

Injured organs	N	
	Blunt	Penetrating
Lungs	0	2
Spleen	3	20
Liver	0	21
Stomach	0	18
Small intestine	0	5
Large bowel	1	10
Pancreas	0	1
Kidney	0	1
Esophagus	0	1
Duodenum	0	1
Main vessel injury*	1	2
Retroperitoneum	1	0
Adrenal	0	1

*inferior vena cava, internal iliac vein, renal vein

TABLE III - Grading of injuries regarding Moore classification.

Grade	Injury severity	N	
		Blunt	Penetrating
1	Contusion (commotion)	0	0
2	Laceration <2 cm	2	36
3	Laceration 2 – 10 cm	6	16
4	Laceration >10 cm		
	Tissue lost =25 cm ²	1	1
5	Laceration and tissue lost >25 cm ²	0	0

TABLE IV - Effects of factors on mortality in patients with traumatic diaphragmatic rupture.

	Survivors	Death	P
	n= 58	n= 4	
Mean age (years)	31.33	28.25	0.568
ISS	15.16	21.25	0.04
Length of defect at diaphragm (cm)	2.91	3.75	0.513
Diagnosis in 24 hours (number of patients)	57(97.3%)	1(1.7%)	0.009
Diagnosis after 24 hours (number of patients)	1(25%)	3(75%)	0.011

Mean diaphragmatic defect diameter was 6.5 cm and 2.2 cm in patients with blunt and penetrating trauma, respectively. Patients were graded regarding Moore classification and there were no grade 1 and 5 injury (Table III).

Diaphragmatic repair was performed via laparotomy in 52 patients, laparotomy plus thoracotomy in 8, and thoracotomy in 2 patients. Sixty patients underwent primary suturing and two had synthetic grafts due to tissue loss and more than 10 cm defect width.

Postoperative complications included atelectasis in 5 patients, pleural effusion in two, sepsis in 2, empyema in one and ileus in one. There were 4 (6.4%) mortalities and two patients with great vessel injury and hemorrhagic shock was lost intraoperatively, others had pneumonia, sepsis and acute respiratory distress syndrome (ARDS).

Time span to diagnosis (within 24 hours or more) and ISS were the factors significantly effecting the mortality, however, age and defect size were not significant (Table IV).

Discussion

Traumatic diaphragm rupture is a rare injury following blunt and penetrating thoracoabdominal traumas and is considered as an indicator for the severity of trauma. There is no definite incidence as most of the major trauma patients are not taken to autopsy in routine.

In our study, most of the diaphragm ruptures (85.4%) were due to penetrating trauma. It is quite higher than the western countries³. The difference between the incidences could be correlated with our patients' living area which is composed of rural region's population located at the far southeast of Turkey with low socio-cultural level, mostly not well educated, and carrying gun is almost a routine. Females have fewer incidences in our series similar to other series, however, as male-dominancy is still an ongoing issue in southeast region of Turkey; males' incidence was seven folds of females in our study while it was four folds in the literature. Also our group composed of young adults as is consistent with other reports¹⁴.

Left posterolateral diaphragmatic rupture is more frequent following blunt traumas because of the weaker structure of this region which is composed of pleu-

roperitoneal membrane. Besides, right hemidiaphragm is congenitally stronger than left side and liver serves an extra protection support³. All blunt trauma patients had left sided rupture as consistent with the aforementioned pathogenesis, however, high incidence of left sided ruptures should be questioned. To our opinion, as almost all of the penetrating injuries are intended to kill, assailant supposed to attack to the heart of the victim which is left sided, however, forensic research is required to elucidate the issue. With this limitation, the only conclusion for left sided ruptures of penetrating trauma can be made as penetrating trauma causes diaphragmatic rupture at the side of injury.

Progress to a hernia formation following a traumatic diaphragm rupture depends on the diameter of defect and volume and physical properties of organs close to the defect. The diameter of defect is usually larger in blunt trauma than penetrating injury^{14,15}. Mean defect diameter was found three fold larger in blunt trauma victims than penetrating injuries in our study. To our results, larger defect size at diaphragm was proportional to the severity of trauma, however, did not have effect on mortality. Results of large volume patient studies required to make further conclusions on defect size and mortality correlation.

As diaphragm lays in-between intrathoracic and intraabdominal organs, concomitant injuries almost always exist. Incidence of adjacent organ injury reaches up to 80-95% in penetrating trauma¹⁴. According to the USA National Trauma Database, concomitantly injured organs are liver, lungs, spleen, ribs, intestine, extremity, kidney, pelvic injury, head and aortic, respectively in frequency^{16,17}. In our study, liver is followed by spleen, stomach, colon in penetrating trauma in decreasing order and spleen was the most included in blunt trauma.

TDR can easily be diagnosed via direct roentgenograms. Since chest x-ray is the cheap, easily reached and less invasive method, it should be the first step for diagnosis. Sensitivity of spiral CT is 71% and specificity is 100% at TDR diagnosis. CT is useful not only in detection of diaphragm rupture but also in determination of co-existing pathologies. However, patient should be hemodynamically stable for CT examination¹⁸. In our study, all patients' ruptures diagnosed preoperatively by chest x-ray without a need for further investigations but

CT examination was required in 22.5% to elucidate the suspicion at roentgenogram. To our opinion, possible traumatic diaphragm rupture should be kept in mind at the examination of a trauma patient's roentgenogram indicating further evaluation with CT in order to decrease time span for the diagnosis which in turn would diminish the mortality and morbidity rates and to avoid misdiagnosis.

Diagnosis of TDR reported to be overlooked in up to 66% of cases regarding non-specific findings in half of the radiological examinations, presence of accompanying organ injury, and being non-insistent on the diagnosis^{9-11,19}. In our study, patients not diagnosed within first 24 hours of injury were diagnosed by CT examination on the following days for diagnosis regarding deterioration of patients' status. Furthermore, patients diagnosed in the first and seventh years were the one's had knife stab injury treated conservatively with overlooked diaphragm rupture which recognized at the radiological examination of the patient for incarcerated hernia at years later⁹⁻¹¹. If TDR is diagnosed in an early period, laparotomy is recommended. Thoracotomy or thoracoabdominal approach is recommended when laparotomy is insufficient or lung injury is in question or diagnosed at a late phase²⁰. In our study, patients with concomitant lung injury underwent thoracotomy and patients with accompanying intraabdominal injury only had laparotomy, however, coexistence of lung and intraabdominal organ injuries required thoracotomy plus laparotomy. Localization and shape of the wound, clinical presentation of the patient and possible related damages of penetrating or blunt trauma leading diaphragm rupture directs the order of diagnostic measures and also the operative strategy¹⁴. To our opinion, laparotomy should be the choice of the procedure in patients with severe trauma as it provides better exposure.

Mortality and morbidity has wide differences regarding the existence of concomitant adjacent organ injury which also increases the severity of injury²¹. Complications encountered in our study were atelectasia followed by pleural effusion, pneumonia, sepsis, empyema and ileus. Mortality and morbidity increases with the herniation to and strangulation of abdominal organs in the thoracic cavity²¹. Mortality rates of TDR are reported to be 1% to 28% and mostly related with accompanying organ injury^{4,12}. Our mortality rate was 6.4%. Major vascular injury with hemorrhagic shock was the mortality reason in our two patients whom had an ISS score of 27. Others had ISS scores of fifteen and eighteen, and mortality was related to postoperative pulmonary complications (pneumonia, ARDS, empyema). To our results, high ISS score correlated with higher mortality rates reflecting the indicative importance of the organ trauma score. In a study of Mihos et al., ISS and hemorrhagic shock found to affect mortality, however, time to diagnosis was not related³. In our study, ISS and time to diagnosis were found to be the factors affecting mortal-

ity. Contrary to the literature, age and diaphragmatic defect size did not affect the mortality²².

To our opinion, the most important issue on diagnosis of traumatic diaphragmatic rupture is suspicion. Since diaphragmatic ruptures may lead to severe and even mortal complications, the possible existence of diaphragmatic rupture should be kept in mind in the lower chest and upper abdominal traumatized patients. Patients with thoracoabdominal injuries should undergo meticulous, definitive and insistent medical examination to reveal diaphragmatic ruptures preoperatively.

Riassunto

Scopo del presente studio è quello di condividere la nostra esperienza su pazienti con rottura traumatica del diaframma, con una revisione dei pazienti sottoposti a trattamento chirurgico per questa patologia tra il 2005 ed il 2010.

La casistica consiste di 62 pazienti, dell'età media di 28,7 anni (compresi tra 15 e 62 anni).

In 43 pazienti si trattava di una rottura del lato sinistro del diaframma (69%), in 17 la rottura era localizzata al lato destro (28%) ed in 2 pazienti la rottura era bilaterale (3%).

In 8 pazienti il trattamento è stato toracotomico, in 50 si è proceduto a laparotomia, ed in 4 l'approccio è stato toraco-addominale.

La mortalità è stata di 4 pazienti (6.4%), in 2 di essi per shock emorragico ed in 2 per polmonite e sepsi.

Pur trattandosi di lesioni non frequenti, le rotture del diaframma sono facilmente disconosciute per effetto mascherante delle concomitanti lesioni viscerali e devono pertanto essere prese in considerazione in caso di traumi del torace inferiore o del settore superiore dell'addome, per effettuare il trattamento più opportuno e diminuire il rischio di mortalità.

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