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Traumatic diaphragmatic ruptures: A multidisciplinary study in a tertiary health center

Travmatik diyafragma rüptürleri: Üçüncü basamak sağlık merkezinde multidisipliner bir çalışma

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ABSTRACT

Background: In this study, we present diagnostic and therapeutic approaches in diaphragmatic rupture cases secondary to trauma and treated using surgical intervention.

Methods: Between March 2010 and December 2020, a total of 24 patients (23 males, 1 female; mean age: 35.0±13.7 years; range, 18 to 61 years) who were operated for traumatic diaphragm rupture were retrospectively reviewed. Preoperative, intraoperative, and postoperative data of the patients were evaluated. Differences between the groups with and without morbidity were analyzed.

Results: The mean total length of stay in the hospital was 16.2±10.9 (range, 6 to 56) days. The morbidity rate was 50% (n=12), and the mortality rate was 4.2% (n=1). In the comparison of groups with and without morbidity, three factors were found to be statistically significant: instability at the time of admission (p=0.009), gastrointestinal system perforation regardless of its location (p=0.014), and rib fracture (p=0.027). There was a significant difference in the total length of hospital stay (p=0.045).

Conclusion: Patients whose condition is unstable at the time of admission to the emergency room and who have gastrointestinal system perforations and rib fractures are more prone to developing morbidity, which prolongs the duration of hospital stay.

Keywords: Diaphragmatic rupture, gastrointestinal system perforation, rib fracture, thoracoabdominal injuries, trauma.

ÖZ

Amaç: Bu çalışmada travmaya bağlı diyafragma rüptürü olan ve cerrahi girişim ile tedavi edilen olgularda tanısal ve tedavi yaklaşımları sunuldu.

Çalışma planı: Mart 2010 - Aralık 2020 tarihleri arasında travmatik diyafragma rüptürü nedeniyle ameliyat edilen toplam 24 hasta (23 erkek, 1 kadın; ort. yaş: 35.0±13.7 yıl; dağılım, 18-61 yıl) retrospektif olarak incelendi. Hastaların ameliyat öncesi, sırası ve sonrası verileri değerlendirildi. Morbiditesi olan ve olmayan gruplar arasındaki farklılıklar araştırıldı.

Bulgular: Hastanede toplam ortalama kalış süresi 16.2±10.9 (dağılım, 6 to 56) gün idi. Morbidite oranı %50 (n=12) ve mortalite oranı %4.2 (n=1) idi. Morbidite olan ve olmayan grupların karşılaştırılmasında üç faktör istatistiksel olarak anlamlı bulundu: başvuru sırasında instabilite (p=0.009), lokasyonundan bağımsız olarak gastrointestinal sistem perforasyonu (p=0.014) ve kaburga kırığı (p=0.027). Toplam hastanede kalış süresinde anlamlı bir farklılık vardı (p=0.045).

Sonuç: Acil servise kabul anında durumu stabil olmayan ve gastrointestinal sistem perforasyonları ve kaburga kırıkları olan hastalar morbidite geliştirmeye daha yatkındır ve bu da hastanede kalış süresini uzatır.

Anahtar sözcükler: Diyafragma rüptürü, gastrointestinal sistem perforasyonu, kaburga kırığı, torakoabdominal yaralanmalar, travma.

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Diaphragmatic rupture (DR) is a rare disease that is difficult to diagnose. The first case was described by Sennertus in 1551 during an autopsy of a patient who died of a stab wound.[1] Among all thoracoabdominal traumas, DR occurs with a probability of less than 5%. While DR is particularly likely to be detected in intra-abdominal or intra-thoracic organ injuries, isolated DR is extremely rare.[2]

In patients who have DR due to abdominal organs that have herniated into the thorax, symptoms occur in the acute period. However, DR can be detected months or even years later.[3] An overlooked DR can cause abdominal organs to herniate into the thoracic cavity in the chronic period, during which, herniated organ(s) can exhibit blood-supply disorders and necrosis, which can lead to serious morbidity and mortality.

In the present study, we aimed to present diagnostic and therapeutic approaches in DR cases secondary to trauma and treated using a surgical intervention.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at the Departments of General Surgery and Thoracic Surgery of Van Yüzüncü Yıl University Faculty of Medicine between March 2010 and December 2020. A total of 24 patients (23 males, 1 female; mean age: 35.0±13.7 years; range, 18 to 61 years) who were operated on for traumatic DR were included. Various preoperative factors were evaluated including demographic characteristics (age, sex), type and location of trauma, time and method of diagnosis and the presence of hemothorax, pneumothorax (PTX), and rib fracture. The intraoperative factors checked were rupture side, incision type, rupture repair type and additional organ injury or injuries. The following postoperative factors were noted: complications, mortality, and length of hospital stay. The factors evaluated during the hospital stay were the requirement for chest tube(s) and blood product(s).

The differences in terms of the pre-, intra-, and postoperative variables in the groups with and without morbidity were evaluated statistically.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean ± standard deviation (SD), and minimum-maximum. Qualitative variables were reported as numbers and percentages. A p value of <0.05 was considered statistically significant.

RESULTS

Penetrating trauma was responsible for the etiology of DR in 20 (83.3%) patients, and blunt trauma was responsible in four (16.7%) patients. The type of penetrating trauma was stab wounds in 13 (54.2%) patients and gunshot wounds in seven (29.2%) patients (Figure 1). The cause of the blunt trauma was falling from a height in two (8.3%) patients and traffic accident in two (8.3%) patients (Figure 2).

Although three patients were operated at an external center and, then, referred to our hospital

Figure 1. Hemothorax, liver laceration and diaphragmatic rupture in a 32-year-old male patient with penetrating trauma (stab wounds).

Figure 2. Hemothorax, rib fracture and diaphragmatic rupture in a 61-year-old male patient with blunt trauma.

Table 1. Preoperative and intraoperative data of patients

No	Age	Sex	Trauma type	Affected side	Rib fracture	First operation	PTX	Diagnosis time	Operation technique	Blood products	Length of ICU stay (day)	Total length hospital stay (day)
1	52	M	Penetrating	Right	No	External	Yes	ER	Laparotomy	4 U ES+ 2 U FFP	6	9
2	22	M	Penetrating	Left	Yes	Inside	Yes	5th day of internation	Laparotomy	None	11	34
3	39	M	Penetrating	Left	No	Inside	Yes	ER	Thoracotomy	None	0	10
4	31	M	Penetrating	Right	No	Inside	Yes	ER	Laparotomy	None	6	10
5	40	M	Penetrating	Right	No	Inside	No	ER	Laparotomy	1 U ES	0	10
6	32	M	Penetrating	Right	No	Inside	No	ER	Thoracotomy+laparotomy	2 U ES	0	11
7	18	M	Penetrating	Left	No	Inside	No	ER	Laparotomy	None	6	15
8	59	M	Penetrating	Left	No	Inside	No	ER	Thoracotomy+laparotomy	None	12	15
9	26	M	Penetrating	Left	No	Inside	Yes	ER	Thoracotomy+laparotomy	None	4	14
10	48	M	Blunt	Right	No	Inside	No	ER	Thoracotomy	None	12	6
11	40	M	Penetrating	Left	Yes	Inside	Yes	ER	Laparotomy	3 U ES+3 U FFP	12	21
12	29	M	Penetrating	Left	No	Inside	Yes	ER	Thoracotomy+laparotomy	4 U ES+2 U FFP	4	27
13	18	M	Penetrating	Left	No	Inside	Yes	ER	Thoracotomy	4 U ES+2 U FFP	8	18
14	49	M	Penetrating	Left	No	Inside	No	3rd day of internation	Laparotomy	2 U ES+1 U FFP	14	9
15	18	M	Penetrating	Left	No	Inside	No	ER	Laparotomy	None	0	14
16	32	M	Penetrating	Right	No	Inside	No	ER	Laparotomy	None	7	9
17	61	M	Blunt	Left	Yes	Inside	Yes	ER	Laparotomy	None	3	11
18	22	M	Penetrating	Left	Yes	Inside	Yes	ER	Thoracotomy+laparotomy	5 U ES+3 U FFP	3	27
19	19	F	Penetrating	Left	Yes	External	Yes	3rd day of internation	Thoracotomy	None	2	56
20	57	M	Blunt	Left	Yes	Inside	Yes	ER	Thoracotomy	3 U ES+2 U FFP	7	15
21	22	M	Penetrating	Right	No	Inside	No	ER	Thoracotomy+laparotomy	2 U ES+2 U FFP	7	12
22	40	M	Blunt	Left	Yes	External	Yes	ER	Thoracotomy+laparotomy	3 U ES	0	17
23	37	M	Penetrating	Left	No	Inside	Yes	ER	Laparotomy	None	0	17
24	30	M	Penetrating	Left	Yes	Inside	Yes	ER	Thoracotomy+laparotomy	None	0	10

PTX: Pneumothorax; ICU: Intensive care unit; ER: Emergency Room, U: Unit, ES: Erythrocyte Suspension, FFP: Fresh frozen plasma.

for follow-up, our clinic performed the first surgical interventions on the remaining patients. The patients who were operated on in an external center underwent emergency operations due to hemodynamic instability. Of 21 patients who were first admitted to our emergency room (ER), 12 (50%) underwent urgent surgery due to hemodynamic instability and general condition disorders.

No chest radiography was performed in any of the cases. Computed tomography (CT) was performed in nine (37.5%) patients who were hemodynamically stable. On CT, DR was observed in six (25%) patients, suspected in two (25%), and not considered in one (4.2%) patient. In addition, on CT scan, eight (25%) patients had fractures in one or more ribs.

In all, 15 (62.5%) patients had PTX, including all the patients referred to our clinic from external centers. In eight (33.3%) patients, the PTX diagnosis was made in an ER. In four (16.7%) patients, PTX was detected on a CT scan. All patients had hemothorax that was detected either before or during surgery.

Intraoperative evaluation showed that the DR was on the right side in 16 (66.7%) patients and on the left in eight (33.3%) patients. In all patients, a chest tube was placed either preoperatively or intraoperatively: on the right side in 15 (62.5%) patients, on the left in eight (33.3%) patients, and bilaterally in one (4.2%) patient.

A laparotomy incision was used to treat DR in 11 (45.8%) patients, and a thoracotomy incision was used in five (20.8%). In eight patients, both types of incisions were used. In all patients, the surgical method used was simple DR repair. In addition to the DR, 20 (83.3%) patients had injuries to intra-thoracic or intra-abdominal organs, most commonly the liver (29.2%). Of those who had liver injury, the first surgery could not control the bleeding in three, and packing was applied to them. All bleeding in the liver was controlled by second surgeries. Table 1 shows the clinical features of the patients and Table 2 shows the accompanying organ injuries and the treatments applied. Repeat surgeries were performed in two (8.3%) patients with intra-thoracic hematomas and one (4.2%) patient with an intra-abdominal abscess.

Erythrocyte suspension (ES) was given to 11 (45.8%) patients (33 units in total), and fresh frozen plasma (FFP) was given to eight (33.3%) patients (17 units in total).

Table 2. Additional organ pathologies accompanying diaphragmatic rupture and treatment of these pathologies

Additional organ pathology	Surgical treatment	n	%
Liver			
G1 injury	None	2	8.3
G2 injury	Suture	2	8.3
G3 injury	Packing (first surgery) Suture (seconder surgery)	3	12.5
Spleen			
G1 injury	None	2	8.3
G2 injury	Suture	1	4.2
G3 and above injury	Splenectomy	3	12.5
Stomach	Wedge resection with primary repair	3	12.5
Colon			
G2 injury	Primary repair	1	4.2
G4 injury	Resection with loop colostomy	1	4.2
G5 injury	Resection with end colostomy	1	4.2
Renal			
G2 injury	None	1	4.2
G4 or G5 injury	Nephrectomy	2	8.3
Pancreas (distal)	Primary repair	1	4.2
Cardiac injury	Primary repair	3	12.5

G: Grade.

Table 3. Postoperative complications and treatments

Postoperative complication	Treatment	n	%
Intra-thoracic hematoma	Surgical drainage	2	8.3
Isolated empyema	Drainage with chest tube	2	8.3
Multi organ failure due to sepsis	Supportive therapy and antibiotherapy	2	8.3
Surgical site infection	Local drainage and daily cleaning	1	4.2
Thoracic infective fistula	Debridement and daily cleaning	1	4.2
Atelectasis	Breathing exercises	1	4.2
Intra-abdominal abscess	Surgical drainage	1	4.2
Isolated pleural effusion	Drainage with chest tube	1	4.2
Empyema+surgical site infection+pleural effusion	Drainage with chest tube+local drainage and daily cleaning	1	4.2

To control postoperative pain, simple analgesics (acetaminophen 10 mg/kg intravenously every 12 h or diclofenac sodium 1 mg/kg intramuscularly every 12 h) were used as the first step. Narcotic analgesics (tramadol hydrochloride 1 mg/kg intravenously every 12 h) were used in patients whose pain persisted despite simple analgesics.

The mean duration of stay in the intensive care unit was 5.1±4.6 (range, 0 to 14) days, while the mean duration of stay in the service was 11.0±11.1 days (range, 0 to 53) days. The mean length of stay in the hospital was 16.2±10.9 (range, 6 to 56) days. Postoperative complications developed in half the patients who were operated for DR. These complications were related to thoracic cavity pathologies in nine (37.5%) patients and intra-abdominal pathologies in three (12.5%) patients. The most common complications were intra-thoracic hematomas and empyema. Table 3 lists postoperative complications.

The morbidity rate was 50% (n=12), and the mortality rate was 4.2% (n=1). One (4.2%) patient, who died was diagnosed on the third day after the trauma, was operated due to colon perforation and died on postoperative Day 14 due to sepsis.

In the comparison of groups with and without morbidity, three factors were found to be statistically significant: instability at the time of admission (p=0.009), gastrointestinal system perforation regardless of its location (p=0.014), and rib fracture (p=0.027). In addition, there was a significant difference in the total length of hospital stay (p=0.045). Table 4 shows the parameters that differed between the morbidity groups.

DISCUSSION

Diaphragmatic rupture is an infrequent complication of thoracoabdominal traumas[2] and is often found together with abdominal or thoracic injuries. Delay in diagnosis and treatment causes complications and mortality. In cases requiring surgical treatment, it should be applied as soon as possible. There has been no significant difference in the methods of surgical treatment over the years, and the main goal is to return the diaphragm to its correct and integrated anatomical position.[4]

Although the incidence of DR is not known exactly due to cases that are missed and those in which treatment is delayed, the literature estimates that the incidence can reach 10%,[5] and it has been reported as ranging from 1 to 7% in blunt traumas[6] and from 10 to 15% in penetrating traumas.[7] While thoracoabdominal gunshot and knife wounds are the most important etiological factors in penetrating trauma, road accidents are the most important in blunt trauma.[8,9] In the present study, penetrating traumas (83.3%) played an important role in DR etiology, which is consistent with the literature.

Although the literature shows no clear sex distribution or age range for DR, it is more common in males.[10-12] While blunt trauma patients tend to be older, having a median age of 44 years, patients with penetrating traumas have a median age of 31 years. Zhao et al.[10] found the median age of DR patients to be 35 (range, 15 to 65) years, and Gu et al.[13] found a median age of 51 (range, 13 to 77) years. In the present study, the mean age was 35.0±13.7 (range, 18 to 61) for all patients, 51.5 years for the blunt trauma group and

Table 4. Parameters that differ between morbidity groups

Characteristics	Morbidity (+) (n=12)				Morbidity (-) (n=12)				
	n	%	Mean±SD	Mean rank	n	%	Mean±SD	Mean rank	*p*
Age (year)[a]			37.3±15.3				32.8±12.1		0.423*
Sex									>0.999**
Male	11	47.8			12	52.2			
Female	1	100			0	0			
First operation center									0.217**
External	3	100			0	0			
Internal	9	42.9			12	57.1			
Trauma type									0.590**
Blunt	3	75			1	25			
Penetrating	9	45			11	55			
Hemodynamic instability (+)		73.3				26.7			0.009**
Diagnose time									0.217**
Emergency room	9	42.9			12	57.1			
Later	3	100			0	0			
Diaphragmatic rupture side									0.193**
Right	2	25			6	7			
Left	10	62.5			6	37.5			
Incision type									0.671***
Laparotomy	6	54.5			5	45.5			
Thoracotomy	3	60			2	40			
Both	3	37.5			5	62.5			
Packing (+)	2	66.7			1	33.3			>0.999**
Additional organ (+)	11	55			9	45			0.590**
Rib fracture (+)		87.5				12.5			0.027**
Perforation in GIS (+)		100				0			0.014**
Liver injury (+)	3	42.9			4	57.1			>0.999**
Splenic injury (+)	4	66.7			2	33.3			0.640**
Cardiac injury (+)	2	66.7			1	33.3			>0.999**
Gastric perforation (+)	3	100			0	0			0.217**
Renal injury (+)	1	50			1	50			>0.999**
Pneumothorax (+)	10	66.7			5	33.3			0.089**
Erythrocyte suspension (units)[b]				14.00				11.00	0.319****
Fresh frozen plasma (units)[b]				14.50				10.50	0.178****
Total hospital stay (days)[b]				15.38				9.63	0.045****
Service (days)[b]				14.83				10.17	0.114****
ICU (days)[a]				4.61				4.67	0.603**

SD: Standard deviation; GIS: Gastrointestinal system; ICU: Intensive care unit; * Independent sample t-test; ** Chi-square test; *** Likelihood ratio test; **** Mann-Whitney U test.

32.5 years for the penetrating trauma group. For both the latter groups, the mean age is consistent with the data in the literature.

Nearly 75% of DR cases due to trauma are diagnosed on the left side, as blunt trauma often causes left DR due to a congenital weakness of the left diaphragm and the protective effect of the bare area in the liver on the right side. In the literature, right-sided diaphragmatic injuries are in the form of case reports. Interestingly, in the present study, DR was most often observed on the right side (66.7% *vs*. 33.3%), the opposite of the cases in the literature. We attribute this to the high number of stab wounds (54.1%) in our cases.

While penetrating trauma usually results in smaller and unilateral injuries, blunt trauma causes larger ruptures, and up to one-third of these ruptures may be bilateral. In both blunt and penetrating traumas, if the size is small, the diagnosis of DR may be overlooked. While small injuries (<2 cm in diameter) are mostly asymptomatic and occult, wider defects (>5 cm in diameter) in the diaphragm can cause hernia symptoms.[14] In the acute period, shoulder pain, vomiting, epigastric pain, and shortness of breath may be observed in patients on admission. On examination, bowel sounds can be heard in the thoracic cavity during auscultation. The absence of lung sounds can also help diagnose DR, but does not make a diagnosis definitive. An important issue that should not be forgotten is that lung sounds decrease or disappear due to thoracic pathologies, including PTX, hemothorax, and direct lung injury.[15]

Chest radiographs can help to show diaphragmatic defects and hernia contents. With proper positioning, the rate of hernia diagnosis can reach 90%.[15] However, due to herniation of the abdominal organs, the air fluid level in the left thoracic cavity or the appearance of the spiral gastric tube may be detected in only 10 to 20% of patients. Chest radiographs after DR can show elevated hemidiaphragm and shifts away from the injury.

In stable patients, CT is the most useful diagnostic tool. In DR, the sensitivity of CT ranges from 14 to 61%, and its specificity ranges from 76 to 99%.[16] The sensitivity and specificity improve to 77% and 98%, respectively, with the use of modern multidetector CT.[17] In CT scanning, the first evaluation can provide direct visualization of the injury, non-visualization of the diaphragm, and visualization of the herniation of abdominal viscera into the thorax. In addition, CT with peri-diaphragmatic contrast extravasation can indirectly suggest DR.[18] In the present study, CT scanning was used as a diagnostic tool for DR in only nine patients and, on CT, DR was observed in six patients, suspected in two and not considered in one patient.

Ultrasonography (USG) also plays a role in evaluating DR. Bedside USG or focused abdominal sonography for trauma (FAST) can provide knowledge about the intra-thoracic and intra-abdominal cavity, if available. It can also show fluid in the pericardium, chest, and abdomen. However, since USG is a radiologist-sensitive method, a negative result does not exclude intra-thoracic and intra-abdominal pathologies.[19] In the present study, USG could not be performed, as there was no USG device in the ER.

Magnetic resonance imaging (MRI) can provide direct coronal and sagittal images, which are well suited for optimal visualization of the entire hemidiaphragm, when the motion is limited by respiratory and cardiac gating. However, these techniques are difficult to perform in polytraumatized patients. Development of faster imaging sequences, improved MRI-compatible physiological monitoring, and improved life-support equipment can enable MRI in most hemodynamically stable trauma patients. Of note, MRI is less readily adapted to the acute trauma setting and should be reserved for patients with an uncertain CT diagnosis or delayed signs of DR.[20] In the present study, MRI was not used in the diagnosis of any case.

Basic resuscitation steps should be applied to all patients admitted to the ER with any type of trauma. Initially, the function of vital organs should be evaluated. After the functions of the vital organs are stabilized, the type and severity of the trauma must be determined. In unstable thoracoabdominal injuries, the relevant clinic(s) should be contacted quickly to evaluate the trauma. According to the symptoms and signs at the time of admission, the patient should be taken into emergency surgery. In contrast, in patients who have severe respiratory distress and low saturation levels, a chest tube should be inserted immediately. In stable patients who have thoracoabdominal trauma, surgery should be planned based on the clinical findings and results obtained using diagnostic imaging tools.

In the surgical treatment of DR, the main goal is to close the defect with interrupted or continuous non-absorbable sutures or mesh, to return abdominal organs in the thorax to the abdomen and to fix additional thoracic or abdominal pathologies. A midline laparotomy is the recommended approach, as it enables exploration of the entire abdominal cavity and repair of additional abdominal problems.[7] The need for thoracotomy should be determined depending on the type of trauma and the accompanying thoracic pathologies.

Video-assisted thoracoscopic surgery (VATS) was first reported as a method of recognizing DR by Ochsner et al.[21] It offers the opportunity to evaluate the entire hemidiaphragm, particularly on the right, and the ability to identify and treat other intra-thoracic injuries. The VATS is best used in stable patients in whom intra-abdominal and contralateral diaphragm injuries are excluded. In some cases, laparoscopy following VATS can help to evaluate the intra-abdominal viscera and inspect the contralateral

hemidiaphragm.[22] In the present study, no VATS was performed in any of the patients.

In stable patients who have penetrating traumas, the incidence of injury to the diaphragm is extremely high, and laparoscopy or thoracoscopy is recommended for diagnosing and repairing missed diaphragmatic injury.[18] However, the literature also contains studies in which thoracotomy is used more frequently in diaphragm repair.[23] In acute left DR, the thoracic approach may be preferred, even if there is no accompanying injury to the thorax, and laparotomy may be added if necessary.[24] In the literature, laparotomy is the most common surgical method,[9,18] as it was in the present study.

Also in the present study, the liver (29.1%) and spleen (25%) were the intra-abdominal organs most frequently affected by trauma, as they were in a study by Kaya et al.,[25] and the ribs (33.3%) were the thoracic organs most frequently affected, as they were in a study by Lim and Park[26]

Another important issue in the treatment of DR is pain control. Although simple analgesics are preferred as the first step to control pain in trauma patients, simple analgesics do not work in most cases, increasing the need to use narcotic analgesics. Pain seriously affects patients' breathing functions and causes postoperative complications, including atelectasis. Therefore, pain control should be provided, and patients should be given breathing exercises to prevent postoperative complications.

The reported morbidity rates from DR range from 40 to 60%, and the mortality rates range from 3.6 to 41%.[24,27] Morbidity in DR is associated with the presence of additional thoracic and abdominal injuries. The most series thoracic complications, including atelectasis, were increased due to thoracic pain due to both surgical incision and rib fracture. In contrast, high-pressure traumas, including gunshot injuries, may cause recurrent hematomas, empyema, and other thoracic complications. These patients may require repeated drainage, debridement, wound cleaning, and surgical intervention.

In abdominal traumas, postoperative complications vary according to the organ(s) affected. In cases of digestive-system perforation, complicated intra-abdominal infections and abscesses may be seen. Interventional drainage procedures or repeated surgical interventions may be required. In cases of solid organ injury, the surgical procedures applied may even include organ resection. In severe trauma cases involving the liver, packing may be required, as the bleeding cannot be controlled. In the present study, packing was applied to three patients due to uncontrolled bleeding. In addition, one patient was operated twice due to an intra-abdominal abscess.

Mortality strictly related to DR is minimal; mortality is usually caused by other associated injuries. The most common causes of death reported in the literature are shock, severe organ failure, and cranial injuries.[28] However, delayed diagnosis of DR may increase mortality up to 30%.[29] In the study of Tarladaçalışır et al.,[12] advanced age (p=0.020) and longer need for intensive care were found to increase mortality. In the present study, one patient who had a colonic injury died from sepsis on postoperative Day 14. The overall morbidity rate was 50% and it's the mortality rate was 4.1%, both rates consistent with the literature.

The most important limitations of the study are that it is a retrospective study, it was planned and conducted in a single center, and the number of patients was low. To obtain more accurate data, prospective, multi-center studies with a more significant number of patients are needed.

In conclusion, traumatic diaphragmatic rupture is a rare disease that can cause serious morbidity and mortality. The most important factors for successful results are early diagnosis and treatment. In unstable patients, emergency surgery should be performed immediately. The choice of surgical approach depends largely on the associated injuries. In stable patients, after evaluation with imaging tools, surgery should be planned. The diaphragm and all thoracoabdominal organs should be carefully explored. While all diaphragm defects can be repaired with simple sutures, mesh can be used for large defects. Patients whose condition is unstable at the time of admission to the emergency room and who have gastrointestinal system perforations and rib fractures are more prone to develop morbidity, which prolongs the duration of hospital stay.

Ethics Committee Approval: The study protocol was approved by the University of Van Yüzüncü Yıl Ethics Committee (date: 12/02/2021; no: 2021/02-17). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: Since it is a retrospective study, there is no need to obtain patient consent.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Conception and design of the work, acquisition, analysis, and interpretation of the data for the work, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved, final approval of the version to be published, drafting the work, designing the work, interpretation of data for the work: D.M.İ.; Drafting the work or revising it critically for important intellectual content; work design; interpretation for work, Final approval of the version to be published: Ü.H.İ.; Acquisition, analysis, or interpretation of data for the work, drafting the work or revising it critically for important intellectual content. Final approval of the version to be published: T.K.

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