Türk Göğüs Kalp Damar Cerrahisi Dergisi 2013;21(3):712-717
doi: 10.5606/tgkdc.dergisi.2013.7261

Original Article / *Özgün Makale*

Evaluation of the patients diagnosed with diaphragmatic rupture in emergency room

Acil serviste diyafram rüptürü tanısı konulan hastaların değerlendirilmesi

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Background: This study aims to review the patient characteristics and management of diaphragmatic injuries in patients who were admitted to emergency room due to thoracoabdominal trauma.

Methods: Between April 2005 and December 2011, medical files of 20 patients (18 males, 2 females; mean age 44.4±13.8 years; range 18 to 72 years) who were admitted to Ankara Atatürk Training and Research Hospital, Emergency Department due to thoracoabdominal trauma and diagnosed with diaphragmatic injury were retrospectively analyzed. The effects of demographic characteristics of the patients, underlying etiology of the disease, diagnostic evaluation, concomitant injuries, treatment received and trauma scores [the Glascow Coma Score (GCS), Revised Trauma Score (RTS), Injury Severity Score (ISS), Trauma Injury Severity Score (TRISS)] on the length of hospital were evaluated.

Results: Four of the patients had penetrating injuries, while 16 had blunt trauma. The initial examination in the emergency room revealed GCS:13.4±2.8, RTS: 5.8±3.1, ISP: 18.8±7.6 and a predicted death rate of 6.4±10.4 according to TRISS. There was no statistically significant difference in the length of hospital stay based on RTS and GCS, whereas the length of hospital stay was significantly longer in patients with ISS scores ≥16, compared to those with ISS scores <16. The mean length of hospital stay of the patients was 20.4±23.1 days. No mortality was seen in any patient.

Conclusion: In cases of thoracoabdominal trauma in the upper abdomen and/or lower thoracic region, particularly, diaphragmatic injury should be considered and the tests should be assessed carefully. In addition, we believe that anatomical scoring systems (ISS) should be preferred rather than physiologic scoring systems (RTS, GCS) in predicting mortality and the length of hospital stay in patients with certain anatomical disorders, which may be life-threatening alone such as rupture of the diaphragm.

Key words: Diagnosis; diaphragm; rupture; treatment.

Amaç: Bu çalışmada acil servise başvuran torakoabdominal travmalı hastalarda tespit edilen diyafram yaralanmalarında hastaların özellikleri ve tedavi yönetimi gözden geçirildi.

Çalışma planı: Nisan 2005 ve Aralık 2011 tarihleri arasında Ankara Atatürk Eğitim ve Araştırma Hastanesi Acil Servise torakoabdominal travma nedeni ile başvuran ve diyafram yaralanması tanısı konulan 20 hastanın (18 erkek, 2 kadın; ort. yaş 44.4±13.8 yıl; dağılım 18-72 yıl) tıbbi dosyası retrospektif olarak incelendi. Hastaların demografik özellikleri, hastalığın altta yatan etyolojisi, tanısal değerlendirme, eşlik eden yaralanmalar, uygulanan tedavi ve travma skorlarının [Glascow Koma Skoru (GCS), Revize Travma Skoru (RTS), Yaralanma Şiddet Skoru (ISS), Travma Yaralanma Şiddet Skoru (TRISS)] yatış süresi üzerindeki etkisi değerlendirildi.

Bulgular: Hastaların dördünde penetran yaralanma, 16'sında künt travma vardı. Acil serviste yapılan ilk muayenede, GCS: 13.4±2.8, RTS:5.8±3.1 ISS:18.8±7.6 TRISS'a göre öngörülen ölüm oranı 6.4±10.4 idi. Revize Travma Skoru ve GKS ile yatış sürelerinde istatistiksel olarak anlamlı bir fark olmamakla birlikte, ISS ≥16 olan hastaların hastanede yatış süreleri, ISS skoru <16 olan hastalara kıyasla, anlamlı olarak daha uzundu. Hastaların hastanede ortalama kalış süreleri 20.4±23.1 gündü. Hastaların hiçbirinde mortalite izlenmedi.

Sonuç: Özellikle üst karın veya alt torakal bölgeyi içeren torakoabdominal travmalarda diyafram yaralanmasının da olabileceği akılda tutulmalı ve yapılan incelemeler dikkatli bir şekilde değerlendirilmelidir. Ayrıca diyafram rüptürü gibi tek başına hayati tehlike yaratabilecek belirli anatomik bozukluğu olan hastalarda mortalite ve hastanede kalış süresinin uzunluğunu tahmin etmede anatomik skorlama sistemlerinin (ISS), fizyolojik skorlama sistemlerinden (RTS, GKS) daha ön planda kullanılması gerektiği kanısındayız.

Anahtar sözcükler: Tanı; diyafram; yırtık; tedavi.

Available online at
www.tgkdc.dergisi.org
doi: 10.5606/tgkdc.dergisi.2013.7261
QR (Quick Response) Code

Received: December 12, 2012 *Accepted:* August 17, 2012

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Thoracic trauma is among the severe injuries that is responsible for 25% of the total deaths due to trauma, and in 1-15% of thoracoabdominal injuries, diaphragm injuries are seen concurrently.[1-3] Despite the high incidence rates, at times diagnostic studies present a difficult puzzle for emergency room (ER) physicians to solve. Currently, although the use of more sophisticated radiological diagnostic methods have made diagnoses easier, it is difficult to determine which patients have diaphragmatic injuries without the support of clinical findings. In fact, 12-69% of patients are not diagnosed in the preoperative period.[4,5] Because of these difficulties, early diagnosis of diaphragm injuries may be overlooked, and this delay may increase the mortality and morbidity rates for these patients.[5]

In this study, we aimed to review the characteristics and management of diaphragmatic injuries in patients who were admitted to the ER of our facility because of thoracoabdominal trauma and investigate the effect of trauma scoring systems for predicting hospitalization time.

PATIENTS AND METHODS

In this study, we retrospectively evaluated 20 patients (18 males, 2 females; mean age 44.4±13.8 years; range 18 to 72 years) who were admitted to the Ankara Atatürk Training and Research Hospital ER between April 25th, 2005 and December 31st, 2011 because of thoracoabdominal trauma. They were then subsequently also diagnosed with diaphragmatic injuries. The demographic data (age, gender), way of admission, type of trauma, other concurrent injuries, diagnostic tests performed, surgical technique, injury site and size, any herniated organ(s), pulmonary complications that developed after surgery, length of hospital stay, and outcome of the patients were evaluated.

The revised trauma score (RTS), a physiological scoring system, the injury severity score (ISS), an anatomical scoring system, and the trauma injury severity score (TRISS), which is determined by using the previous two scoring systems and is used for predicting the average expected mortality rate were calculated according to the results of the first examination in the ER. For the RTS, we used the weighted RTS formula [RTS = (0.9368 x GKS) + (0.7326 x SK) + (0.2908 x SS)] as defined by Champion et al.[6] The abbreviated injury scale (AIS) grades trauma with scores ranging from 1 (minor) to 6 (fatal). To calculate the ISS, the body is divided into six regions (head and neck, face, chest, abdomen, upper and lower extremities, and other external areas), and the sum of the squares of the AIS values of the three most seriously injured regions is then calculated. Scores range from 1-75. An ISS score of 16 and above indicates a major trauma.[7] The TRISS utilizes a combined scoring system which evaluates the probability of survival in trauma patients by using the RTS, ISS, AIS, and the age of the patient.[8] These scoring systems have been used all over the world to determine preventable deaths, evaluate treatment sufficiency, and compare the results of various medical centers.

The findings of this study were evaluated using the IBM SPSS Statistics 20.0 software program (IBM Corporation, Armonk, NY, USA). Categorical data was presented in terms of percentage, and quantitative data was presented in terms of mean and standard deviation. Student's t test was used for quantitative syllogism of a feature between the two groups, and the results were evaluated using a 95% confidence interval (CI), with $p<0.05$ being considered as significant.

Patients who were diagnosed outside of the ER (during surgery or hospitalization) because they underwent emergency surgery before a further examination could be performed due to unstable vital signs were excluded from the study as well as those who were admitted to the ER for reasons other than thoracoabdominal trauma. In addition, patients diagnosed with spontaneous or late type diaphragmatic hernias were also not included.

RESULTS

All of the patients were brought to our facility by emergency ambulance service. Four had penetrating injuries while 16 had blunt trauma, with the most common cause of the blunt trauma being traffic accidents (n=11, 55%). Stab wounds were the most common culprit for the penetrating injuries (n=3, 75%). In 18 patients (90%) the rupture was on the left side, and one of the two ruptures on the right side was caused by falling from a lofty height while the other was caused by penetrating trauma. The length of the rupture was 6.25±6.07 cm in the penetrating trauma cases and 6.9±4.0 cm in the blunt trauma cases (mean, 6.7±4.3 cm). According to the American Association for the Surgery of Trauma-Organ Injury Scale (AAST-OIS),[9] 70% of the diaphragm ruptures were grade 3 (Table 1, 2).

In the first examination in the ER, the patients had a Glasgow coma score (GCS) of 13.4±2.8, an RTS score of 5.8±3.1, an ISP score of 18.8±7.6, and a TRISS score of 6.4±10.4. None of the patients had an RTS score below 4. In addition, the GCS score was below 8 in two patients and between 9-13 in five others. In 12 of the patients, the ISS score was over 15. This high score was due to the fact that only those with ruptured diaphragms were enrolled in the study. Furthermore,

Table 1. Demographic data and clinical findings

	n	Mean±SD
Age		44.4±13.8
Gender		
Male	18	
Female	2	
Hospital stay (days)		20.4±23.1
Side		
Left	18	
Right	2	
Rupture length (cm)		6.7±4.3
AAST-OIS		
Grade 1	0	
Grade 2	3	
Grade 3	14	
Grade 4	2	
Grade 5	1	

SD: Standard deviation; AAST-OIS: American Association for the Surgery of Trauma-Organ Injury Scale.

there was no statistically significant difference in the duration of hospitalization between the RTS and GCS, whereas in patients with an ISS score of 16 and over, the hospitalization time was significantly longer than those with ISS scores under 16 (p=0.039).

For diagnosis, posteroanterior (PA) chest radiographs were initially performed for all of the patients in the recovery room via a portable X-ray device, and the results were normal in only three patients. The most frequently detected abnormality was rib fractures (n=13). Abdominal ultrasonography (USG) was also performed on 17 patients in the recovery room, with the most common abnormality being free fluid in the abdomen in seven patients. However, it also revealed no pathologies in nine patients. Thoracic computed tomography (CT) was performed for all patients whose vital signs were stable after further examination. Additionally, USG and/or direct abdominal radiography were used to detect other pathologies, and nine patients (45%) also underwent an abdominal CT because of those findings.

The thoracic CT of 13 patients reported a diaphragm rupture, but the most common abnormality was once again rib fractures (n=14, 70%) (Table 3).

After the chest surgery, the general surgery was consulted with 19 cases. There was no accompanying injury in six of these patients; however, extremity fractures were present in five others. Furthermore, renal pathology was seen in four of the 19 patients and spleen lacerations in three others with thoracic pathologies (Table 4). There was no statistically significant difference when the length of hospital stay was compared between the patients with additional pathologies and those with none (p>0.05).

Surgical interventions were performed via the thoracoabdominal route in 12 patients, the thorax in seven patients, and the abdomen in one patient. In 10 of the patients, no herniation was observed through the area of the ruptured diaphragm, and in the 10 with herniation, the most frequently herniated organs were the stomach (n=9, 45%), spinal column (n=6, 30%), liver (n=4, 20%), spleen (n=3, 15%), and small intestine (n=2, 10%). In nine patients (45%), multi-organ herniation was observed. In 10 cases, the diaphragm ruptures were repaired directly, and in the other 10 who had a herniation of the abdominal organs into the thorax, the ruptures were repaired after these organs were replaced. Primary repair was performed for all of the patients, and no prosthetic material was used. Number zero or one silk yarn sutures were then inserted one by one using a “U” technique. One patient developed postoperative complications related to pneumonia, and one had complications due to empyema. Yet another patient developed problems because of both pneumonia and empyema. The average hospital stay was 20.4±23.1 days, and no mortality was reported.

Besides the 20 cases enrolled in this study, four other patients who were admitted to the ER during the same period were diagnosed with a ruptured diaphragm during surgery, and one was diagnosed in the clinic after he was hospitalized. In addition, one patient who was admitted to the ER with complaints due to heavy lifting was diagnosed with spontaneous (atraumatic) diaphragm rupture without thoracoabdominal trauma, and two patients with a history of previous traffic accidents (10 years and 15 days earlier, respectively) were diagnosed with delayed diaphragmatic rupture.

DISCUSSION

The incidence rate of diaphragm injuries following major traumas is not exactly known because the attention of doctor often shifts to the apparent serious injuries.

Table 2. The mechanism of injury

Blunt trauma (n=16)	n	%	Penetrating trauma (n=4)	n	%
Traffic accident	11	55	Penetrating wounds	3	15
Fall from a lofty height	4	20	Gunshot wounds	1	5
Hit by a falling object	1	5			

Table 3. Pathologies detected via diagnostic tests

Diagnostic tests								
PA chest X-ray			Thoracic CT			Abdominal USG		
Pathologies	n	%	Pathologies	n	%	Pathologies	n	%
No pathology	3	15	Rib fractures	14	70	Not performed	3	15
Rib fractures	13	65	Rupture of the diaphragm which may be compatible with the existing image	13	65	No pathology	9	45
Hemothorax	10	50	Hemothorax	12	60	Free fluid	7	35
Pneumothorax	4	20	Pneumothorax	7	35	Liver pathology	4	20
Pulmonary contusion	4	20	Pulmonary contusion	6	30	Splenic pathology	1	5
Diaphragmatic elevation	3	15	Diaphragmatic elevation	3	15			

PA: Posteroanterior; CT: Computed tomography; USG: Ultrasonography.

While understood, this action may cause these types of injuries to be overlooked.[10] In several studies, the percentage of overlooked cases of diaphragm ruptures was reported to range from 1-7% with blunt traumas,[3] and 10-15% with penetrating traumas.[2] Three-fourths of all diaphragmatic injuries are due to blunt traumas while one-fourth are to the result of penetrating traumas.[11] Our results were similar as 80% of the ruptured diaphragms were due to blunt trauma and 20% occurred because of penetrating trauma.

Although imaging methods along with detailed physical examinations hold an important place in the diagnosis of diaphragmatic rupture, there is no single modality that is capable of establishing a definitive diagnosis.[5] Posteroanterior chest X-ray is the standard imaging method that is used in the initial evaluation of patients with chest trauma, but the diagnostic value of a chest radiograph in ruptured diaphragms varies between 28 and 70%.[12] Therefore, the use of highly sensitive multidetector thoracic CT (MDCT) is now recommended as the standard for the diagnosis of diaphragmatic injuries.[13] Collar sign image which results from the interruption and narrowing of the diaphragm caused by a herniated organ and/or omental adipose tissue is an important finding in the MDCT because it aids in the diagnosis of a hernia in the diaphragm.[14] In addition, when it is not possible to confirm the diagnosis, even with these examinations, and suspicion persists, additional diagnostic tests, such as magnetic resonance imaging (MRI), video-assisted thoracoscopic surgery (VATS), laparoscopies, fluoroscopies, and diagnostic peritoneal lavage, can also be performed.[5] In our study, chest radiography and chest CT were performed for all of the patients for the diagnosis of diaphragmatic rupture, and these two imaging techniques were sufficient without the need for further tests. However, the presence of some pathologies in the thoracic CT that were not seen in the chest radiographs suggests the need for further examination, but this would depend on the results of a physical examination and the mechanism of the injury.

Blunt diaphragmatic injuries occur on the left side 8-10 times more than the right side because the left medial posterolateral tendino-muscular area remains the weakest region of the diaphragm during embryological development due to the protection on the right side offered by the liver under the diaphragm.[15-17] The formation of herniation through this defect also depends on the diameter of the defect and the physical properties and volume of the closer abdominal organs. The diameters of the defects caused by blunt trauma

Table 4. Consultations and additional pathologies

Consultations	n	%	Additional pathologies	n	%
Thoracic surgery	20	100	Extremity fractures	5	25
General surgery	19	95	Renal lacerations	4	20
Orthopedics	10	50	Intestinal perforations	4	20
Brain surgery	5	25	Splenic lacerations	3	15
Urology	4	20	Liver lacerations	2	10
Ear, nose, and throat	1	5	Subarachnoid hemorrhage	2	10
Cardiovascular surgery	1	5	Bladder lacerations	1	5
			Rectus muscle hematomas	1	5

are usually greater than the ones caused by penetrating injury.[5,18] Frequently herniated organs include the stomach and colon,[10,17] with herniation of the liver and spleen only rarely occurring.[18] In our study, the herniations were usually on the left side in accordance with the literature, and the most commonly herniated organs were the stomach and colon. However, the diameters of the defects, whether due to penetrating or blunt trauma, were approximately the same.

Various scoring systems along with intensive care scoring systems have been used for the evaluation of patients with multiple traumas. These two systems are preferred because of their ability to predict the prognosis, particularly the mortality rate. The main factor for the 0% mortality rate in our study was that the RTS and GCS scores were below the cut-off values. However, the ISS scores were above the cut-off value of 16 and above because ruptured diaphragms were present in all of the patients. Therefore, we suggest that the ISS scores reflect the prognosis better than the RTS and GCS since an anatomical scoring system is more effective for predicting mortality than a physiological scoring system, especially in patients who have a particular anatomical disorder such as a ruptured diaphragm that is not life-threatening on its own.

Injuries that accompany diaphragm ruptures are the most important causes of mortality in these cases. Several studies have reported a 75-100% rate of intra-abdominal organ injuries in conjunction with diaphragmatic injuries. We associate the relatively lower rates in our study with the inclusion of patients whose general condition was stable. On the other hand, the ineffectiveness of additional pathologies on the duration of hospitalization suggests that thoracic trauma has an important impact on the amount of time patients spend in the hospital.

Diaphragm ruptures require surgery because spontaneous closure does not occur. The surgical method depends on the localization and duration of the rupture and whether or not any abdominal organs have herniated into the chest cavity. The ruptured area is fixed by primary repair or by using a synthetic graft and interrupted number zero or 1 silk sutures. All of the patients in our study were diagnosed during the acute phase and underwent surgery. Ten of them had intra-abdominal organs herniating into the thoracic cavity, and nine had additional abdominal injuries. A thoracotomy incision was performed on seven of the patients while a laparotomy was performed on another. In addition, both thoracotomy and laparotomy incisions were performed on 12 patients. In all cases, the ruptures were repaired primarily by interrupted sutures.

The mortality rate were reported as 14.63% in a study by Çobanoglu et al.[17] and 5.6% in a study by Zeybek et al.[18] In our study, we excluded the patients who had undergone emergency surgery before any further examinations took place because the vital signs were not stable and the diagnosis of diaphragmatic rupture was made during the surgical procedure. This may explain our significantly lower mortality rate (0%) when compared to the literature. Performing appropriate interventions in the early phase, having patients with a relatively low number of additional intra-abdominal organ injuries, and conducted the successful administration of appropriate medical treatment in the intensive care unit (ICU), in spite of the longer hospitalization times, (20.4±23 days) may be other reasons for the low mortality rate in our study.

Conclusion

In cases of thoracoabdominal traumas affecting the upper abdominal and/or lower thoracic regions, diaphragmatic injury should always be considered and investigations should be carried out with care. Tests should be repeated, and further radiological examinations should be performed if suspicion persists. In addition, we suggest that anatomical scoring systems like the ISS should be preferable to physiological scoring systems like the RTS and GCS for predicting mortality and hospitalization time in patients with certain anatomical disorders which may be life-threatening, such as a ruptured diaphragm. However, our results need to be supported by future studies conducted with a larger sample size.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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