

## Blunt Injuries of the Diaphragm

AHMED S. IBRAHIM, M.D.; MOHMED A. ABDEL  
HAKIM, M.D.; MAHMOUD EL BATAWI, M.D.  
and NABIL A. ALI, M.D.

*The Departments of Surgery and Cardiothoracic Surgery,  
Benha Faculty of Medicine.*

### Abstract

Over a 9 year period, 15 patients (12 males and 3 females) with blunt traumatic rupture of the diaphragm were managed in Benha university hospital. Their age ranged from 18-49 years. Automobile accident was the main traumatic mechanism in 12 patients. Three patients presented with diaphragmatic hernia due to missed detection of diaphragmatic rupture a month to 2 years following the accident. The other 12 patients presented with acute diaphragmatic ruptures which could be diagnosed on emergency laparotomy (4 patients), within 24 hours (6 patients) and after 48-72 hours (2 patients). Left and right diaphragmatic ruptures were encountered in 12 and 3 patients respectively. Trans abdominal repair was the procedure of choice in the acutely injured patients due to the presence of associated abdominal injuries in all of them, with extension to right and left thoracotomy in 4 patients. Thoracic approach was used in the repair of missed cases. Diaphragmatic tears were repaired by interrupted mattress silk sutures (12 Cases), or double breasting (3 Cases) when enough tissues were available. Mortality rate was 20% which was not related to diaphragmatic injuries but reflecting the severity of associated traumatic injuries. Awareness of the possibility of traumatic diaphragmatic ruptures with, major blunt trauma to abdominothoracic region and the presense of strongly suspicious clinical and radiological evidence of diaphragmatic rupture remain the best way of making early diagnosis and hence successful management of the condition.

### Introduction

TRAUMATIC rupture of the diaphragm is an internal injury which is rarely lethal itself, but which if ignored or undetected may produce serious complications associated with gastrointestinal herniation [1]. Though the diaphragm can rupture spontaneously [2] and may be torn during surgical operations [3], most diaphragmatic rup-

tures are caused by indirect (crushing) or direct (penetrating) injuries to the chest, abdomen or both [1]. Traumatic diaphragmatic rupture is more frequently diagnosed these days due to the changing spectrum of the trauma and increased awareness of this condition.

This study reviewed the clinical experience with blunt traumatic diaphragmatic

rupture in Benha university hospital in a 9 year period. The objectives were to define the clinical signs so as to increase the accuracy of diagnosis and to analyze the results of treatment in an attempt to improve the management of patients with these injuries.

### Clinical Material

During a 9 year period (1983 - 1992), 15 patients were managed in Benha university hospital for traumatic diaphragmatic rupture. All patients were exposed to blunt trauma to thoracoabdominal regions through variable mechanisms (table 1). Patients consisted of 12 males and 3 females who ranged in age from 18 to 49 years.

Table (1): Mechanisms of Injury.

Mechanism of trauma	No. of patients
Automobile accident	12
Fall from height	1
Falling of a heavy object	1
Kick on the abdomen	1

### Diagnosis:

Diagnosis of acute traumatic diaphragmatic rupture could be made in the first 72 hours following the accident in 12 patients. Diagnosis of 4 cases was made during emergency laparotomy carried out in the first few hours following hospital admission. Patients were suffering marked circulatory collapse due to intraabdominal haemorrhage. They were rapidly resuscitated and operated upon. Chest radiography during resuscitation demonstrated mild to moderate haemothorax, in addition to fracture 1-3 ribs in each case (Figs. 1,2).

Physical findings and chest radiography were conclusive for the diagnosis of trau-

matic diaphragmatic ruptures within the first 24 hours of the accident in 6 patients. The patients presented with mild to moderate degrees of circulatory collapse which responded well to resuscitative measures. All 6 patients had got evidence of peritoneal irritations due to associated abdominal injuries proved later on exploration. Chest pain, dyspnoea, cough, vomiting, epigastric pain and abdominal discomfort were the commonest presenting symptoms. The presence of mediastinal shift, absent breath sounds on the side affected, audible bowel sounds in the chest, haemothorax and gastrointestinal shadows in the thorax had made sure diagnosis of diaphragmatic ruptures in 3 patients (Fig. 3). Diagnosis of the other 3 patients was highly suspicious due to the presence of multiple suggestive findings; flail chest, haemopneumothorax, mediastinal shift, undefinable diaphragm and associated fracture pelvis (Fig. 4). Diagnosis was confirmed during laparotomy in all of the above 6 Cases.

Diagnosis in two patients was delayed to 48-72 hours after admission. They were suffering slight abdominal discomfort, infrequent vomiting and chest pain. Their vital signs were within normal ranges with a good general condition. Abdominal examination showed tender epigastrium and left hypochondrium. The mechanism of trauma was a compression one in both of them (falling of a heavy object over part of chest and a kick on the abdomen with the patient against the wall). Chest X-ray showed no abnormality except for bilateral fracture ribs in the first patient. The subsequent clinical and radiological follow up had augmented the suspicion of the presence of diaphragmatic tears due to the detection of a colonic shadow in the chest in one (Fig. 5) and elevated left diaphragmatic outlines with left haemothorax in the other. Asso-

ciated two superficial tears of left lobe of the liver (first patient) and subcapsular splenic haematoma (second one) were found on laparotomy later on.

Three patients presented with variable combinations of respiratory embarrassment, Chest pain, gastrointestinal discomfort and dysphagia. They reported that they had been involved in car accidents a month to two years before. The first patient had suffered right sided haemothorax without other associated injuries which was managed by intercostal tube drainage for 15 days. The patient complained of persistent right sided chest pain following removal of the tube. Chest radiography and C.T scan a month later demonstrated right sided diaphragmatic tear with herniating intrathoracic right lobe of the liver (Fig. 6). later on during surgery cruciate right copular tear was found with the right lung adherent to underlying liver tear. The other 2 patients underwent exploratory laparotomy following their accidents 1-2 years before, which proved negative in the first, while splenic lacerations were found in the second one with subsequent splenectomy. The patient with negative previous exploration had mild haemothorax in association with the previous accident managed by aspiration 24 hours later. Chest X ray and Ba-meal of the last 2 patients had confirmed the presence of diaphragmatic hernia which was thought to be due to the possibly missed diaphragmatic tears during the initial laparotomy following their previous accidents (Fig. 7).

Left diaphragmatic rupture was present in 12 patients and on the right side in 3 patients. Two or more associated injuries were present in the 12 patients with the acute traumatic rupture of the diaphragm (Tables 2 and 3).

Intercostal tube drainage during the preoperative resuscitation were done in 3 cases under local anaesthesia to improve their respiratory distress.

#### *Operative Approach and Findings:*

Laparotomy was the standard approach to all acutely injured patients (12 cases) for proper dealing with the associated intra abdominal injuries and the diaphragmatic tears. Extension to right and left thoracoabdominal incisions were proceeded in 4 patients for proper dealing with right copular tears, liver tears (2 patients) and severe left sided haemothorax (2 patients). Thoracic approach through left 8 th and right 4 th intercostal spaces were chosen for missed chronic cases in two and one patients respectively due to the usually present intrathoracic adhesions in chronic cases.

Most of the diaphragmatic disruptions were in the posterolateral areas of the left side of the diaphragm (12 cases) involving both tendinous and muscular portions. Length of diaphragmatic lacerations were 6-12 cm in 9 patients and less than 3 Cm in 4 patients (table 2). Stomach, colon and omentum were the commonest organs to herniate followed by liver, spleen and small intestine. Omentum was found to plug small left diaphragmatic tears in 4 patients. Diaphragmatic repair was carried out with interrupted mattress silk sutures (12 patients). Double breasting repair (3 patients) was applied when enough tissues were available. No complete avulsion was found and no mesh was used.

Associated abdominal injures (Table 3) were managed at the same time. Splenectomy was performed for splenic lacerations in 6 patients and subcapsular haematoma (one patient). Gastric, hepatic and lung lacerations were repaired, while necrotic

Table (2): Operative Findings of Diaphragmatic Tears.

	No. of patients
<i>Side of diaphragmatic tear:</i>	
Left	12
Right	3
<i>Size of diaphragmatic tear:</i>	
Less than 3 Cm	4
3-6 Cm	2
6-9 Cm	4
9-12 Cm	5

Table (3): Associated Injuries with Traumatic Rupture of the Diaphragm.

Injured organ	No. of patients
<i>Thoracic:</i>	
Rib fracture	8
Lung lacerations	4
<i>Abdominal:</i>	
Spleen	7
Gastric laceration	2
Hepatic tear	3
Omental tear	4
Mesenteric tear	1
<i>Soft tissue (Hand, face and limbs)</i>	4
<i>Orthopedic:</i>	
Pelvic fractures	4
Comminuted fracture femur	2
Minor fractures	2
<i>Head injuries:</i>	
Simple form of head injuries (concussion - fissure fracture skull)	5
Fracture base + brain laceration	1
Fracture vertebral body without associated neurological injuries	2

omental tissues were excised. Transverse mesenteric tear had lead to acute ischaemia of 30 cm ileal loop, managed by resection anastomosis.

Peritoneal toilet with normal saline was routinely done. intercostal tube and peritoneal drains (when required) were then fixed in place followed by closure of the incision in layers. Forceful reinflation of the lung at the end of the repair was done always to minimise postoperative atelectasis and to ensure proper air tight repair of lung lacerations.

Associated soft tissue or limb injuries were managed as necessary. Rib fractures were managed conservatively. Plaster cast, external fixation and traction were applied for the management of orthopedic injuries according to the type of fracture.

No fatal neurological injuries were found among the studied patients except a single case of fracture base and brain laceration which had lead to one of the recorded mortalities.

### Results

There were three deaths in the present study (20%). The first case was a 31 year male struck by motor vehicle and transferred to the hospital in marked shock, severe intraabdominal haemorrhage due to ruptured bilharzial spleen, in addition to fracture base of the skull. Patient was resuscitated rapidly and explored before diagnosis of the diaphragmatic tear. Patient died few hours after surgery due to irreversible brain damage. Operative mortality was recorded in 28 years old male who underwent splenectomy for an extensive lacerations followed by repair of 8 cm diaphragmatic tear. Severe bleeding from left side of the thorax occurred following insertion of the intercostal tube. Incision was

converted to thoracoabdominal one. Descending aortic tear was demonstrated to be the cause of death. Massive pulmonary embolism on the 11 th postoperative day caused the third mortality in a 49 year old female.

Postoperative period of all patients showed 8 morbidities. Massive pulmonary embolism had lead to single mortality. Minor basal lung collapse and pneumonia complicated 3 cases. Left empyema thoracica developed in 32 year old male due to contaminated left pleural space by spillage of gastric secretions from gastric tear of the intrathoracic herniated stomach, induced by the preoperative blind insertion of intercostal tube. left subphrenic abscess complicated a single case which was managed by ultrasonic guided aspiration. moderate form of wound infection occurred in 3 cases. No complications followed the repair of the 3 cases with chronic diaphragmatic hernias.

Table (4): Mortality and Morbidity in the Studied Group.

	No. of patients	%
Mortality	3	20
Morbidity:	8	53.3
Atelectasis (basal)	2	
Pneumonia	1	
Wound infection (moderate)	2	
Empyema	1	
Subphrenic abscess	1	



Fig. (1): Chest roentgenogram demonstrating a left sided haemothorax. The lucent area below the right cupula of the diaphragm proved later to be caused by air leakage from gastric tear. Patient had left copular tear too.

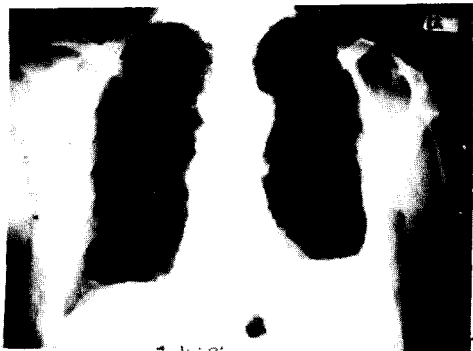


Fig. (2): Chest X-ray taken on admission of 30 year old male, following car accident. Note left haemothorx and fracture of 3rd and 4th ribs. Although X-ray is abnormal, it is not diagnostic for diaphragmatic tear. Patient proved to have left couplar tear which was plugged with omentum.



Fig. (3): Gastric shadow of intrathoracic herniated stomach and haemothorax. Diagnosis of acute diaphragmatic rupture was easily made during preoperative period.

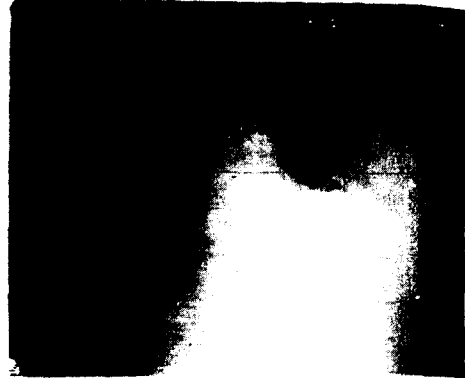


Fig. (4): Chest X-ray of 26 old male shows fracture of 5th and 6th ribs, left haemothorax and elevated left copula of diaphragm. patient had left diaphragmatic tear.



Fig. (5 A)



Fig. (5 B)

Fig. (5 A-B): Chest roentgenogram (2 views), 72 hours after hospital admission of a male patient (23 years), demonstrating an intrathoracic colonic loop in left chest. Initial X-ray following admission showed no abnormalities.



Fig. (6 A)



Fig. (6 B)

Fig. (6 A-B): Chest X-ray (2 views) of 21 year male patient 30 days after being exposed to car accident showing: Elevated right copula, haemothorax and compressed right lung shadow. Right oblique view demonstrates right basal chest shadow.



Fig. (6 C): C.T. of the same patient showing right copular tear.



Fig. (6 D): Operative repair of the cruciate right copular tear of same patient.

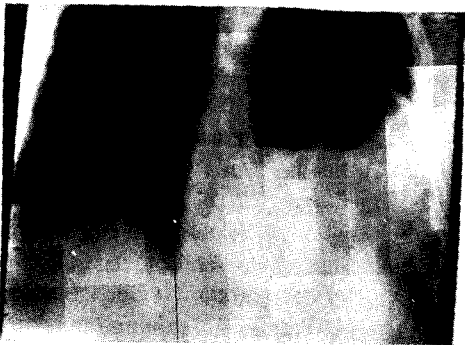


Fig. (7): Ba. meal demonstrating intrathoracic herniated stomach due to missed detection of diaphragmatic tear 2 year before, following involvement of the patient in car accident.

### Discussion

Although systemic approach to diagnosis and management in trauma patient has developed over past decades, traumatic diaphragmatic rupture is considered a difficult diagnostic problem particularly in cases following blunt thoracoabdominal trauma, since overlooked diagnosis is liable to be followed months or years later by the development of full picture of diaphragmatic hernia [4,5,6]. Penetrating injury of the diaphragm carries a minor diagnostic difficulty as all patients are usually explored without hesitancy with subsequent operative diagnosis in case of missed preoperative one.

Several reports considered blunt trauma to be the major cause of diaphragmatic rupture [7,8,9], while others consider penetrating trauma to be the common cause [10,11,12]. Blunt trauma was the only cause of diaphragmatic rupture in the present study, as most of the multiple trauma patients in Benha university hospital are victims of car accidents due to the location of the hospital on the Cairo Alexandria highway.

Left sided diaphragmatic tears were predominant among our patients (12 cases) than right side affection (3 cases). This finding is conformed with other reports [12,13]. The relative infrequency of right sided injury in blunt trauma is usually attributed to the buffering action of liver in protecting the diaphragm [14,15]. During abdominal trauma a tenfold increase in pressure can occur in the abdomen, transmitting a sudden blow of kinetic energy through the dome of diaphragm [13]. Any position of the diaphragm may be injured; however the majority of tears occur in radial direction in the posterolateral area of the left side of the diaphragm [14] which corre-

late with the embryologic areas of weakness [2,16]. The previous finding is corresponding with the location of the diaphragmatic tears in the present study.

Diaphragmatic disruption rarely occurs alone in patients with blunt trauma [17]. In the present study 2 or more associated injuries were present in all 12 cases with acute traumatic rupture of diaphragm (table 3).

Diagnosis of blunt diaphragmatic rupture is frequently missed because of the presence of associated injuries, minimal initial symptoms, in addition to minimal specific radiological evidences which may be missed with other chest conditions if not properly interpreted [18]. According to different reports [18,19,20] 10-30% of blunt diaphragmatic tears especially those of the side escape proper diagnosis to present later by simple or complicated pictures of diaphragmatic herniation. The difficult diagnosis of right diaphragmatic tears is usually due to the misinterpretation of the herniated liver as elevated normal diaphragm in chest radiography [19]. The present study included 3 cases in whom the initial diagnosis of diaphragmatic tears had been missed. Exploratory laparotomy in 2 of them possibly had missed the initial tears most probably due to improper inspection of both diaphragmatic leaves and/or the poor consideration of the presence of such injury. Traumatic rupture of the liver and right copula of diaphragm in the third patient were initially managed as a simple case of right haemothorax for 15 days and proper diagnosis was made one month after the initial trauma. The above mentioned observations stress the fact that patients who are exposed to blunt thoracoabdominal trauma and managed conservatively or did not show evidence of diaphragmatic injuries on exploration, should



be followed up for sometime for early detection of possible occurrence of diaphragmatic hernia, which carries a high mortality rate if presented initially with complications.

Twenty to forty per cent of acute phrenic tears are diagnosed during emergency laparotomy for intraabdominal bleeding [10,20,21]. Four patients of the studied group were diagnosed on the same way, though their chest radiography were non specific (mild to moderate haemothorax). Time consuming diagnostic procedures are required in critical Polly trauma management and detection of diaphragmatic tears will depend mainly on thorough inspection of both diaphragmatic leaves, a fact which should be always considered by the trauma Surgeon.

Preoperative diagnosis of blunt diaphragmatic rupture in relatively stable patients is based primarily on the awareness of the surgeon with its possibility because specific clinical and radiological data are usually few. The diagnosis depends on a strong suspicion based on the combination of clinical and radiological data gained [18]. History of trauma to trunk, chest pain, dyspnea, immobility of the chest, mediastinal shift, diminished breath sounds and audible peristalsis in the chest are important associated symptoms and signs. The suspected diagnosis is usually augmented by the presence of disrupted pelvic ring denoting a high intraabdominal pressure wave [13]. Associated fracture pelvis was present in 4 of our patients. Properly interpreted chest radiography is the most important diagnostic tool. The presence of an opacity in the chest, large air filled bubbles, an undefinable diaphragm, or displacement of mediastinum should make the diagnosis suspicious [1]. Christoph [22]

diagnosed 51% of diaphragmatic ruptures within 4 hours of hospital admission and 62% within 24 hours. Arendrup and Jensen [7] diagnosed 52% of their patients within 24 hours, while Arie et al. [21] diagnosed 50% of cases during 24 hours. Six patients of the present group (50% of acutely injured patients) were diagnosed in the first 24 hours.

Diagnosis of 2 cases in the present report was delayed to 48-72 hours due to absence of early radiological and minimal physical findings. They were exposed to compression form of trauma. The initial absence of pathognomonic signs with considerable major trauma to the trunk could be deceiving to the treating surgeon, so frequent clinical and radiological observations in the first few days following injury must be done in such situations.

Operative management is indicated whenever the diaphragmatic rupture is diagnosed and the patient is able to sustain the surgery. The diaphragmatic repair should be performed as soon as possible because of the risk of rapid respiratory impairment [20]. When a patient has other life threatening conditions that need more investigations, repair can be delayed, but a nasogastric tube must be inserted and the surgeon must be prepared to operate at any time [20].

Most of the studied patients (12 cases) had acute diaphragmatic ruptures managed operatively through transabdominal approach. It is now a well accepted rule that laparotomy is the primary operative approach for the repair of the acutely ruptured diaphragm, because of the significant associated intraabdominal injuries [13, 17, 23]. Among the managed patients we had to proceed to 7 splenectomies, repair of 5 hepatic tears (3 patients) and 2 gastric

tears, resection of 4 necrotic omental tears and resection anastomosis 30 cm. length of ileal loop.

In the presence of marked thoracic bleeding, right sided phrenic tear and inaccessible hepatic tears, one should not hesitate to convert the approach to left or right thoracoabdominal one [21]. Extension to left and right thoracoabdominal incisions were indicated in 4 cases.

Eight morbidities had complicated the studied patients (53.3%). Preoperative blind insertion of intercostal tube caused gastric tear of the herniated intrathoracic stomach which predisposed to the development of empyema thoracica. The previous complication points to the importance of avoidance of blind insertion of intercostal tube during the preoperative period in suspected cases of diaphragmatic disruption whenever possible.

Traumatic diaphragmatic hernia due to blunt trauma implies a severe trauma with a high incidence of associated injuries. The high mortality rate in these cases is related to the total damage to the body rather than to the diaphragmatic injury [6,24,25,26]. Three mortalities (20%) were recorded among the studied patients but the incidence becomes higher (25%) if related to acutely injured patients alone. The 3 mortalities were not related to the diaphragmatic injuries (irreversible brain damage, descending aortic tear and pulmonary embolism). Other reports recorded different incidences of mortality rates with blunt trauma; 7%, 12.5% and 28.6% [20,21,27]. Such variations depend upon the severity of associated injuries and the involvement of vital organs or great vessels in the process of trauma.

In conclusion the awareness of the pos-

sibility of traumatic diaphragmatic ruptures with major thoracoabdominal traumas and the presence of strongly suspicious clinical and radiological evidences of diaphragmatic rupture remain the best way of making early diagnosis and hence successful management of the condition. Regular follow-up of patients with major blunt thoracoabdominal trauma managed conservatively or surgically is advised for early detection of possible later occurrence of diaphragmatic hernia which carries a high mortality rate if presented initially with a complication. In the presence of suspected acute diaphragmatic ruptures, blind insertion of intercostal tube during the preoperative period may induce injury to herniating intrathoracic viscus, that is why the procedure should be restricted to cases with life threatening respiratory distress.

#### References

- 1- MCCOLLUM C. and ANYANWU C.H.: Management of traumatic rupture of the diaphragm. *Br. J. Surg.*, 74: 181-83, 1987.
- 2- SOLOMON J., FELLER N. & LEVY M.J.: A case of spontaneous rupture of the diaphragm. *J. Thorac. Cardiovasc. Surg.*, 58: 221-4, 1969.
- 3- SWARTZ D., LIVINGSTON C., FERMIN T., MACK J., TRINKE J.K. and GROVER F.L.: Intrapericardial diaphragmatic hernia after subxiphoid epicardial pacemaker insertion, case report. *J. Thorac Cardiovasc. Surg.*, 88: 633-5, 1984.
- 4- ADAMTHWAITE D.N.: Traumatic diaphragmatic hernia: *Surg. Ann.*, 15: 73-97, 1983.
- 5- ADAMTHWAITE D.N.: Diaphragmatic hernia presenting itself as surgical emergency. *Injury*, 15: 367-69, 1984.
- 6- American Colloge of surgeons: Field cate-

- gorization of trauma patients and Hospital trauma index (Appendix E). Bull. Am. Coll. Surg., 65: 28-33, 1980.
- 7- ARENDRUP H. and JENSEN B.: Traumatic Rupture of the diaphragm. Surg. Gynecol. Obstet., 154: 526-30, 1982.
  - 8- BROWN G. and RICHARDSON J.: Traumatic diaphragmatic hernia: A continuing challenge. Ann. Thorac. Surg., 39: 170-73, 1985.
  - 9- FAJOLU O.: Traumatic diaphragmatic hernia. J. Nat. Med. Assoc., 76: 1163-64, 1984.
  - 10- DREWS J.A., MERCER E.C. and BENFIELD J.R.: Acute diaphragmatic injuries. Ann. Thorac. Surg., 16: 67-77, 1973.
  - 11- GOURING A. and GARZON A.: Diagnostic problems in traumatic diaphragmatic hernia. J. Trauma, 14: 20-31, 1974.
  - 12- MEADS G.E., CARROLL S.E. and PITT D.F.: Traumatic rupture of the right hemidiaphragm. J. Trauma, 17: 797-80, 1977.
  - 13- DE LA ROCHA G., CREEL R. and MULIGAN: Diaphragmatic rupture due to blunt abdominal trauma. Surg. Gynecol. Obstet., 154: 175-80, 1982.
  - 14- HOOD R.M.: Traumatic diaphragmatic hernia. Ann. Thorac. Surg., 12: 311-24, 1971.
  - 15- MC CUNE R.P., RODA C.P. and ECKERT C.: Rupture of the diaphragm caused by blunt trauma. J. Trauma, 16: 531-73, 1976.
  - 16- HARRINGTON S.W.: Traumatic diaphragmatic hernia. Surg. Clin. North. Am., 30: 691-70, 1950.
  - 17- WARD R.E., FLYNN T.C. and CLARK W.P.: Diaphragmatic disruption secondary to blunt abdominal trauma. J. Trauma, 21: 35, 1981.
  - 18- LUCIDO J.L. and WALL C.A.: Rupture of the diaphragm due to blunt trauma. Arch. Surg., 86: 989-99, 1963.
  - 19- ANDRUS CH and MORTON J.H.: Rupture of the diaphragm after blunt trauma. Am. J. Surg., 119: 686-93, 1970.
  - 20- GILLES B., ABDELKRIM K., ROBERT G., SERG. D., FERMAND L. and GUY L.: Blunt diaphragmatic rupture. Am. J. Surg., 148: 292-95, 1984.
  - 21- ARIE B., VAN VUGT and SCHOOTS F.: Acute diaphragmatic ruptures due to blunt trauma: A retrospective analysis. J. Trauma, 29: 693-86, 1989.
  - 22- CHRISTOPHI C.: Diagnosis of traumatic diaphragmatic hernia: analysis of 63 cases. World J. Surg., 7: 277-80, 1983.
  - 23- DAJEE A., SCHEPPS D. and JURIEY EL.: Diaphragmatic injuries. Surg. Gynecol. Obstet., 153: 31-2, 1981.
  - 24- BAKER S., O'NEIL B. and HADDON W.: The injury severity score; A method for describing patients with multiple injuries and evaluating emergency care. J. Trauma, 14: 187-96, 1974.
  - 25- CHAMPION H.R.: The Trauma score. Cri. Care Med., 9: 627-76, 1982.
  - 26- VAN DER WERKEN, LUBBERS E.J.C. and GORIS R.J.A.: Ruture of the diaphragm by blunt trauma as a marker of injury severity. Injury, 15: 149-52, 1984.
  - 27- SHARMA P.: Diaphragmatic rupture: Not an uncommon entity - personal experience with collective review of the 1980's. J. Trauma, 29: 678-82, 1989.