

# Traumatic Diaphragmatic Rupture – A Clinical Experience

Anita Bhalla<sup>1</sup>, G. Ravindra<sup>2</sup>, Benedicta Coelho<sup>3</sup>

## ABSTRACT

**Introduction:** Traumatic diaphragmatic injuries are potentially life-threatening due to herniation of abdominal organs into the pleural cavities. They can be easily overlooked on initial diagnostics and a high index of suspicion is required.

**Aim:** To analyse the various traumatic diaphragmatic hernias.

**Material and methods:** A clinical study to analyse 50 patients in our experience with patients suffering from traumatic diaphragmatic rupture.

**Results:** 18-50 yrs of age group is the most affected age group with diaphragmatic hernias, gender wise males with blunt injuries are more in study. Right sided is the more affected side. The cause of diaphragmatic rupture was blunt injuries in 23 cases and penetrating injury in 5 cases. 3 patients with acute presentation had uneventful recovery, 2 patients had bile peritonitis and one died. In the cases with late presentation, all patients had uneventful recovery but for 9 patients who had intestinal obstruction. On the 6<sup>th</sup> post-op day, one patient with –acute intestinal obstruction and sepsis, died.

**Conclusions:** Morbidity and mortality of diaphragmatic ruptures are mainly determined by associated injuries or complications of diaphragmatic herniation like incarceration of viscera or lung failure. Early diagnosis helps to prevent severe complications. Laparotomy is an adequate surgical approach for diaphragmatic repair.

**Keywords:** Traumatic Diaphragmatic Rupture

## INTRODUCTION

Blunt diaphragmatic rupture is not an uncommon injury, mostly noteworthy as a marker of severe acute trauma. It occurs in [0.8-5] percent of hospitalised automobile accident victims and in approximately 5% of the blunt trauma patients those undergo EL.(Emergency laparotomy)

The pre-operative diagnosis can often be difficult and masked and overshadowed by other major skeletal, or neurosurgical injuries, and hence a delay in diagnosis is implicated which in turn result in increased morbidity and mortality.

Late presentation of traumatic diaphragmatic hernias is of those which are missed during the primary evaluation. There may be a recent past history of blunt trauma to the chest or abdomen and it may be a trivial one, so as not to cause any immediate external injuries and hence may not be investigated and evaluated. They may present at a later date with mild respiratory embarrassment or intestinal obstruction and strangulation when it is of long standing duration, presenting catastrophically. Most of the diaphragmatic ruptures may not be confirmed or even suspected pre-operatively. However, a stringent exploration of the abdominal cavity and its upper limits during an EL is highly yielding in confirming a diaphragmatic breach. This study can alert and enlighten the emergency trauma surgeon to look for such injuries.

## MATERIAL AND METHODS

It was a clinical study of 50 patients who presented or rather diagnosed as diaphragmatic hernias at Gandhi Hospital. The study was conducted in the department of cardio-thoracic surgery, Gandhi hospital, Secunderabad, Telangana.

### Inclusion criteria

Age group – 15 – 70 yrs, ASA grades-1,2 and 3, Acute or Late traumatic

### Exclusion criteria

Age below 15 yrs, all congenital diaphragmatic Hernias), ASA grade 4 and above, Hiatal (esophageal) hernia

A total of 50 patients, 40 of them were acute traumatic and 10 were late traumatic cases. All of them were evaluated for detailed clinical history and modality of trauma and mechanism of injury, blunt/ penetrating, Clinical examination are documentation.

### Investigations

major surgical profile, X-ray chest, abdomen both erect with nasogastric tube, USG-abdomen and chest, CT/CECT chest Chest radiography is the standard in the advanced trauma life support (ATLS) protocol for a trauma workup. Approximately 23-73% of traumatic diaphragmatic ruptures will be detected by initial chest radiography, with an additional 25% found with subsequent films. Chest radiography is most sensitive for detecting left-side hernias.

Chest radiographic findings that indicate traumatic rupture include the following:

Abdominal contents in the thorax, with or without signs of focal constriction

(“collar sign”)

Nasogastric tube seen in the thorax

Elevated hemi-diaphragm (>4cm higher on the left than on the right)].

### Distortion of diaphragmatic margin

Forty cases were already taken up for emergency exploratory

<sup>1</sup>Associate Professor, Department of CT Surgery, Osmania Medical College and Hospital, Hyderabad, <sup>2</sup>Professor and HOD, Department of CT Surgery, Gandhi Medical College and Hospital, Hyderabad, <sup>3</sup>Post Graduate Student, Department of CT Surgery, Gandhi Medical College and Hospital, Hyderabad, India

**Corresponding author:** Dr. Anita Bhalla, MBBS, MS, M.Ch (CTVS), Associate Professor, Department of CT Surgery, Osmania Medical College and Hospital, India

**How to cite this article:** Anita Bhalla, G. Ravindra, Benedicta Coelho. Traumatic diaphragmatic rupture – a clinical experience. International Journal of Contemporary Medical Research 2019;6(1):A1-A5.

**DOI:** <http://dx.doi.org/10.21276/ijcmr.2019.6.1.5>

laparotomy by the emergency surgical team with definitive indications and intraoperative calls received for 35 anticipated cases with preoperative diagnosis of traumatic diaphragmatic hernias and 5 unanticipated cases where intraoperative diaphragmatic rupture and herniation's were identified. After extending the vertical incision contents were reduced, ragged edges were trimmed and edges apposed with 1 ' prolene interrupted sutures. For all these cases, an intercostal drain was inserted under water seal and anchored only postoperatively. Those with late presentation, with a past history of trauma [days to months ago] had typical history of gradual onset of shortness of breath, both post-prandial and effort related and post prandial discomfort and chest pain, and orthopnea. One case presented with severe nausea and vomiting, dehydration, fever of 2 days hypotension, 90 mm. temperature of 102-degree F and was toxic with a total WBC count of 17,220/mm<sup>3</sup> and 80% toxic band forms. All these 10 cases o late presentations were also subjected for the same panel of investigations and taken up for surgical repair as semi emergencies. All these cases had left posterolateral thoracotomies where contents were reduced and repair was done with 1 ' prolene interrupted sutures. An intercostal drain was inserted under water seal and anchored.

One of the cases, who had a toxic presentation was anticipated to have a bowel obstruction ended up in abdominal extension of the incision and hence a thoracic-abdominal incision. He had a constricting adhesive band literally causing ring like constriction at the traumatic diaphragmatic orifice which was totally narrowed. Orifice was incised wider adhesions were released and contents were dropped into the abdominal cavity. However, the sigmoid bowel was viable and hence there was no bowel resection. Diaphragm was repaired with 1 ' prolene interrupted sutures. An intercostal drain was inserted under water seal and anchored.

The data obtained from the history, examination, radiological investigations. Operative findings and post-operative course and follow up after discharge were then analysed.

#### **CT findings indicative of rupture include the following**

Direct visualization of injury

Segmental diaphragm nonvisualization

Intrathoracic herniation of viscera

“collar sign”

Peridiaphragmatic active contrast extravasation

Ultrasonography (focused assessment with sonography for trauma [FAST]: Has been reported to detect diaphragmatic hernias during visualization of each upper quadrant, the movement of the diaphragm was noted to be decreased in patients with diaphragmatic hernias. This technique is limited in patients who are on mechanical ventilation because of the positive pressure of the thoracic cavity.

#### **Surgical management**

If the diaphragmatic injury is discovered during the acute phase of trauma, the standard surgical approach of laparotomy or, less commonly, thoracotomy. The generally accepted protocol in the acute setting is that a diaphragmatic is approached via a colostomy because concomitant intra-

abdominal injuries are more likely to be present than thoracic injuries.

The problem regarding which approach to use, arises when the diaphragmatic injury goes unnoticed for months or years. Most surgeons approach long-standing hernias via a transthoracic or thoraco-abdominal approach because the herniated intra-abdominal contents tend to be firmly attached to intrathoracic structures. Making a transabdominal approach difficult.

Minimally invasive techniques for diaphragmatic repair are becoming more common than before. with advances in technology and surgical skills, repairing both acute and chronic diaphragmatic hernias is possible with laparoscopic, thoracoscopic, or combined approaches.

#### **Operative details**

As in any case of trauma, the patient's condition must be stabilized, and he or she must be resuscitated to the extent possible before operative treatment. People with traumatic hernias frequently have concomitant injuries and require emergency exploration.

With traumatic ruptures, the surgical approach depends on the timing of the diagnosis with the surgical intervention. In the acute phase of trauma, an abdominal approach is preferred. In the latent phase of trauma, a transthoracic approach may be necessary because patients often have adhesions to the intra thoracic organs.

Acute injuries are repaired with monofilament permanent sutures. Small lacerations may be repaired by using interrupted, horizontal mattress, or figure-eight stitches: larger lacerations may be repaired with continuous or double-layered closures. Absorbable sutures are associated with a high rate of recurrence. There is some limited evidence to suggest that the use of biologic mesh in traumatic diaphragmatic repair may be feasible, at least in chronic cases.

Laparoscopic abdominal exploration in the setting of trauma is becoming a popular way to determine diaphragmatic integrity is retained. It provides a minimally invasive mechanism by which the diaphragm can be directly viewed to determine if an injury has occurred. In the absence of other intra-abdominal injuries, the diaphragm can easily be repaired by applying laparoscopic techniques.

The best utility of laparoscopy is with penetrating thoracic and flank injuries when intraperitoneal penetration is being considered and if a projectile has injured the diaphragm.

#### **RESULTS**

In total 50 patients, causes of diaphragmatic hernia in 40 patients is acute traumatic [80%] and 10 patients, it is late traumatic (20%).

Surgical procedure carried out were: Laparotomies in 35 cases, Emergency thoracotomies in 5, Emergency thoracotomy with abdominal extension in 1 and Elective thoracotomies [late presenters] in 9 cases. 18-50 yrs of age group is most effected age group with diaphragmatic hernias, gender wise males with blunt injuries are more in study (table-1). Blunt right sided injuries were more in the

Age intervals (in yrs)	Number of patients	Percentages
<18	2	4
18-50	40	80
51-60	5	10
61-65	3	6
Gender		
Males	41	82
Females	9	18
Type of injury		
Blunt	35	87.5
Penetrating	5	12.5

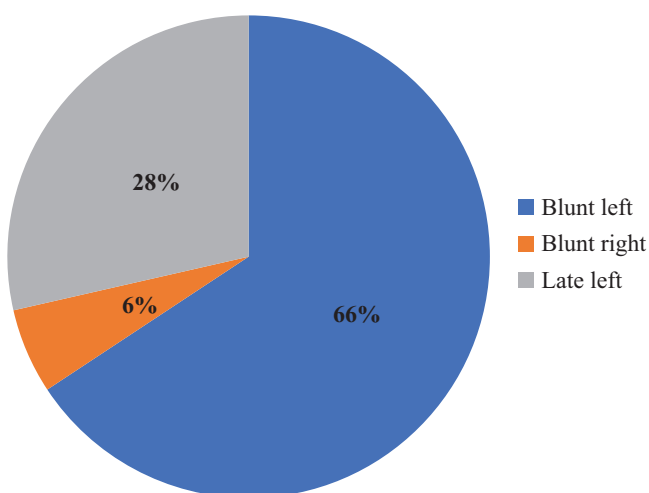
**Table-1:** Demographic details in study

Blunt acute	Number of patients	Percentages
Right side	11	27.5
Left side	24	60
Penetrating injuries		
Right sided	3	7.5
Left sided	2	5
Total	40	100

**Table-2:** Depending on Type of injury

Complications	Number of patients	Percentages
Acute blunt		
Uneventful	33	82.7
Death	2	5
Acute penetrating		
Uneventful	4	10
Late		
Uneventful	9	12.5
Death	1	5

**Table-3:** Complications associated in study



**Figure-1:** Site of diaphragmatic rupture

study (table-2).

Site of diaphragmatic rupture (figure-1): Penetrating injury-5 cases, Right sided-3, left sided-2

Right sided diaphragmatic+laceration 7 hepatic segment-1  
 Right sided diaphragmatic+ laceration 8 hepatic segment-1

Right sided diaphragmatic+ laceration 5 hepatic segment-1  
 Left sided diaphragmatic+ grade 3 splenic injury-2  
 In late case on post-OP 6<sup>th</sup> day, one patient died with acute intestinal obstruction [EL] sepsis.

Follow up was done for surviving cases for at least two years. There were no long-term complications like recurrences. Out of the 14 post thoracotomy cases 5 females and 4 males had post thoracotomy syndrome which were medically managed and referred to pain clinic for further management. Among the EL cases 3 patients developed acquired hernias all these were obese females with BMI above 30 and also with comorbid condition like type 2 diabetes. Two of them had epigastric and one had left paraumbilical hernia. All three of them were referred to the endocrinology and subsequently were taken up by the general surgical team for the mesh plasties.

**DISCUSSION**

Diaphragmatic rupture occurs due to blunt or penetrating trauma which is usually an acute presentation in a polytrauma scenario, is either clinically suspected and diagnosed and confirmed by the radiological studies and imageology. The visualisation of a high costal [anterior or posterior] area or in the vicinity should arise a high index of suspicion of a diaphragmatic breach when respiratory distress, reduced breath sounds in the corresponding hemithorax and audibility of bowel sounds in the chest on auscultation are present. Another presentation may be an emergency laparotomy for some definitive solid organ injury or an exploratory laparotomy, while exploring the diaphragmatic rupture and herniation of abdominal contents in to the thoracic cavity may be eye witnessed by the operating surgical specialist and hence these injuries are not missed out.

It is a blunt injury with minor external or major external orthopaedic injuries or a major neurosurgical injury which needs emergency attention and thus overshadowing the minor diaphragmatic injury or a tiny breach and thus may go unnoticed and patient may come with a late presentation of shortness of breath vague chest discomfort or a dramatic intestinal obstruction.

Several papers report a higher proportion of young male patients in the 4<sup>th</sup> decade of life with traumatic diaphragmatic rupture.<sup>2</sup> This is consistent with the observations in our study where the age interval 18-50 years and 82% of these patients were male.

**Incidence**

Accounts for about 0.8-1.6% of blunt trauma abdomen. Approximately about 4-6% of the patients who undergo emergency laparotomies for trauma have a diaphragmatic injury. Traumatic ruptures of the diaphragm are often the result of severe accidents like blunt or penetrating trauma. Blunt or indirect trauma is mainly caused by traffic accidents or fall from height.<sup>3,4</sup> It commonly leads to laceration of the posterolateral part as this develops as the weakest part during embryological period and is hit by a pressure gradient at the time of high-impact accidents.<sup>5,6</sup> Penetrating or direct trauma to the diaphragm can be caused by gunshot injuries,

stab wounds or impalement lesions.<sup>7</sup> The ratio of blunt to penetrating trauma is a mirror of regional socioeconomic conditions. In the literature reports of blunt trauma are more common (approximately 75%), but the ratio differs from 3:1 to 1:8 according to different series.<sup>4,6</sup>

Although the true incidence of diaphragmatic rupture is not known, data from the literature suggests that it is an uncommon event.<sup>3</sup> It is seen in 1–7% of major blunt trauma and 10–15% of patients with penetrating trauma.<sup>3,8</sup> This confirms our observation of only 14 cases over a period of 8 years in a hospital being a regional trauma referring center.

### Mechanism of injury

Shearing of the stretched membrane, with sudden increase in the intra abdominal pressure, transmitted as a pressure wave, pushing the viscera acting as a viscous fluid against the transmembrane [i.e, the diaphragm] and avulsing it at the point of its attachment is considered as a possible mechanism of injury in blunt trauma. Most of these injuries occur on the left side [68.5%]. Right side injuries account for 24.2% and about 1.5% are bilateral diaphragmatic injuries and 0.9% may be associated with a pericardial rupture when the pressure wave is enormous in speed and intensity. Another 4.9% of the blunt injuries may remain unclassified without any outstanding major injury to be categorised and hence under the umbrella term nonspecific blunt polytrauma. Right sided diaphragmatic injuries are associated with more grave injuries as the greater force of disruption is required. A positive pressure gradient of minimum of 20 cm of water b/w the intraperitoneal and intrapleural cavities is required to draw the abdominal contents into the pleural cavity anti-gravitationally: in a severe blunt trauma this pressure may be beyond couple of hundreds.

### Confirmation of Diagnosis

A simple chest X-ray is diagnostic when the nasogastric tube is seen in the chest. The “collar sign” is seen when the abdominal contents are seen in the thorax with or without constriction. Elevation and distortion of the hemidiaphragm are corroborative signs.

### FAST

Focused abdominal sonography for trauma can also be extended as focused thoracic sonography for trauma and is a very good non-invasive simple and quite confirmatory and a quick diagnostic aid.

### CT and CECT

CT and CECT is indicated whenever renal parameter are not contraindicating the use of a contrast dye. CECT is an absolutely indispensable diagnostic tool as it helps to delineate any abdominal [intra and retroperitoneal] organ injury.

### Management

When a diagnosis of diaphragmatic rupture is suspected in the poly trauma scenario and if the patient is in shock, military anti-shock garments are contraindicated lest it causes cardio-respiratory embarrassment. An air –fluid level in the thorax with respiratory chest/abdomen distress

may mislead the emergency physician to insert an ICD, and unfortunately if may be the bowel or gastric air-fluid level which may complicate the simple issue of herniation into a complicated hollow viscus perforation in the thorax and hence may lead to life-threatening complications like sepsis and mediastinitis. patients should be stabilized and taken up for emergency. Most of the time, it is an abdominal approach through a laparotomy incision where one can address onto the abdominal visceral injury as well. However late presentation with isolated diaphragmatic injury may be approached through a thoracotomy; even then it may need an abdominal extension when it is a large hernia, long standing and with adhesions and hence the difficulty in reduction only by thoracic approach. Minimally invasive [both thoracoscopic] methods may be applied for small defects which are detected early which yield high cosmetology, Shorter hospital stay, early ambulation less post-operative pain and cost-effective but needs surgical expertise and high trauma centre.

In this clinical study, the laparotomy remained the gold standard in all the emergency or acute presentations [i.e. in all the 35 cases] and the other 5 had thoracotomy [ posterolateral] as they were stab or penetrating injuries. Other 10 cases, which had late presentation, all had thoracotomy approach only except one which presented as blow obstruction needed an abdominal extension. We did not use any prosthetic mesh for repair as most of them were emergency RTA cases.

Poly trauma is the most common surgical emergency encountered. Due to the high rise in the number of MVA blunt or penetrating trauma to the abdomen and chest are common, whenever an EL is performed a thorough intra operative inspection and digital palpation examination of diaphragmatic injury or breach must be performed so as not to miss the undiagnosed diaphragmatic injury.<sup>9,10,11</sup>

When a patient comes with vague chest discomfort, breathlessness or features suggestive of intestinal obstruction with the history of trauma in the recent past a high index of suspicion of diaphragmatic hernia should be considered as a late presentation of missed out tiny which has evolved into herniation over a period of time. This hernia is amenable to correction by minimal access surgery when the rent is small and even a mesh can be used for repair specially in obese people. When a conservative management for a blunt abdominal injury is the line of management, still a diaphragmatic injury is suspected then a thoracoscopy may be performed initially as a final diagnostic tool and if the injury is confirmed the procedure can be converted in to a therapeutic one in the same setting. If the pre-existing diaphragmatic eventeration is posing a diagnostic dilemma once previous medical records and X-rays can be reviewed and a definitive diagnosis may be arrived at and un-warranted surgical stress can be avoided.

### CONCLUSION

Males are more susceptible for acute trauma be it blunt or penetrating; as more often being outdoors. More number of trauma cases are on probably due to young alcoholics and

drunken driving in spite of imposing stringent traffic rules and penalties for forfeiters. Thorough clinical examination, battery of investigations, and emergency services and an expeditious intraoperative inspection of both the hemi diaphragm to rule out minor most diaphragmatic injuries and a high index of suspicion towards late presentation of a diaphragmatic hernia. An X-ray chest and erect abdomen may be considered before the planned discharge or a screening fluoroscopy. Patient should be advised follow up at any of the alarming respiratory symptoms.

For smaller diaphragmatic defects and at an earlier presentation, thoracoscopy or laparoscopic intervention may be considered.

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**Source of Support:** Nil; **Conflict of Interest:** None

**Submitted:** 04-11-2018; **Accepted:** 20-12-2018; **Published:** 03-01-2019