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Traumatic Diaphragmatic Rupture with Transthoracic Herniation of Abdominal Organs: A Case Series and Our Experience

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ABSTRACT

Introduction: Diaphragmatic rupture is a rare pathology that is reported in less than 0.5% of all trauma cases, with signs and symptoms that can lead to misdiagnosis. To effectively diagnose and treat this illness, clinicians must maintain a high index of suspicion. We present a series of cases of a large diaphragmatic rupture with transthoracic herniation of the stomach small intestine and large intestine that was successfully repaired, along with a literature review. **Methods**: The data and information are collected from the Department of Surgery Gandhi Medical College and Hamidia Hospital, Bhopal. We present our experience of traumatic diaphragmatic injury patient management of five patients who presented to our emergency department. **Results**: These cases highlight the importance of diaphragmatic rupture and its associated intra-abdominal injuries when treating trauma patients. With missed diaphragmatic injuries leading to a potential morbidity rate of 30% and a mortality rate as high as 10%.one should be alert while treating these patients

Key Words: *Diaphragmatic rupture, Trauma, diaphragmaticinjury, bowel herniation BTDR (Blunt Traumatic Diaphragmatic Rupture)*

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INTRODUCTION:

Sennertus originally documented diaphragmatic rupture in 1541, and it is quite rare and difficult to detect this condition [1]. It happens in less than 0.5% of cases, with the majority (67%), followed by blunt injuries (33%), induced by a penetrating mechanism [2,3]. The left side is the most commonly harmed, with the stomach being the most commonly herniated organ, followed by the spleen. Motor vehicle collisions are the most common cause of blunt diaphragmatic injuries [1].

The pathophysiology of this type of injury is unknown, but the most widely accepted theory describes an increase in intra-abdominal pressure caused by a blunt mechanism that creates an adequately high-pressure gradient between the abdomen and chest to cause rupture and following visceral intrathoracic herniation [1]. Normal intraperitoneal and intrapleural pressure gradients are 7-20 cmH2O, but with traumatic traumas, this positive pressure gradient can surpass 100 cmH2O, resulting to rupture and herniation [4].

The most common signs and symptoms include dyspnoea, chest pain, abdominal distention, and loss of breath sounds over the affected hemithorax [5]. This may be mistaken as a pneumothorax, resulting in inappropriate procedures such as a chest tube into a herniated organ. To accurately identify and manage this illness in a timely manner, one must have a high index of suspicion.[5]

A high-energy force is necessary for the diaphragm to rupture in cases with a blunt mechanism, which is frequently accompanied with other life-threatening injuries. As a result, when a diaphragmatic rupture is diagnosed, the surgeon must be prepared to look for further injuries. This pathology is a sign of severe trauma [6].

We present a series of rare cases of a large diaphragmatic rupture with transthoracic herniation of the stomach small intestine and large intestine and other organs that was successfully repaired, along with a related literature review.

METHODS

The medical records and radiographs of 5 patients who presented with TDR (traumatic diaphragm rupture) in our hospital between January to September 2022 were viewed prospectively. Factors evaluated were, patient sex, age, mode of injury, location of TDR (right, left, or bilateral), mode of diagnosis, time to diagnosis, herniation of various intra-abdominal organs, whether bowel perforation was present or not, presence of preoperative shock and requirement intubation, Response to the resuscitation, associated other injuries, underlying diseases, operation time and procedure, morbidity and mortality, and factors predictive of patient outcomes

Case 1 was a 47 year old Male, who presented to department of surgery in emergency with history of trauma due to accidental fall from moving vehicle, followed by which he was admitted at nearby hospital for 3 days (Table no 1) and investigated accordingly. During investigation of patient, they found on x ray chest there was no left lung visible and few bowel loops were present over left side (fig 2).

Case 2 was a 24 year old male, who presented to department of surgery in emergency with history of trauma due to RTA and patient got rolled under a heavy vehicle. Patient was referred from the district hospital on the same day. On investigation of the patient we found left sided diaphragm defect through which bowel loops seen herniating into the left side of the thorax.(fig 1.)

Case 3 a 35-year-old male who got stuck under a heavy vehicle followed by RTA was presented to department of surgery in emergency. He also had bowel loops in the left side of the thorax in x-ray chest and in CECT there were bowel loops found along with the lung (fig.3, fig.4.). He also had a small bowel perforation (Table no 2)

Case 4 was a 15-year-old male who had history of RTA due to collision with a heavy vehicle was presented to department of general surgery in emergency. This patient also had a pericardium rupture (Table 2.)

Case 5 was a 75-year-old male who had a history of penetrating trauma to the epigastrium region due to hit by animal(bull) during the farm work. He was treated at local hospital and brought to our hospital 2 days after trauma, this patient had left lobe of liver and transverse colon herniated into the thorax and also had a bowel perforation (Table.2.)

Out of the total 5 cases presented in the span of 10 months 4 were blunt trauma due to heavy vehicle collision and 1 was penetrating trauma. 3 had left sided TDR and 2 had right sided TDR (Table 1.), bowel perforation was presented in 2 cases, pericardial injury was present in 1 case. Other associated injuries were present in 4 cases (table.2)

Table no 1. Table showing Age, Sex, Cause of Injury, Location of TDR, Mode of Diagnosis, Time of Presentation to Hospital

S.no	Age	sex	Cause of injury	Location of TDR Right /Left /Bilateral	Mode of diagnosis	Time of presentation
Case1.	47	M	Accidental fall from moving vehicle	Left	Xray chest +Ncct of chest and abdomen	Patient presented 3 days after the trauma
Case 2.	24	M	Rollover under the heavy vehicle	left	Xray chest +Ultrasound abdomen and chest	Presented on the same day of trauma
Case 3.	35	M	Accidental fall and got stuck under the heavy vehicle	left	Xray chest +CECT of chest and abdomen	Presented one day after the trauma
Case 4.	15	M	RTA due to collision between 2wheeler and heavy vehicle	Right	Visible chest wound +CECT abdomen and chest	Presented 2days post trauma
Case 5	75	M	Hit by bull during farm work	Right	Ultrasound chest and abdomen	Presented 2days post trauma

Fig.1.CECT OF abdomen and chest showing bowel loops in chest

Fig.2. Xray chest showing bowel loops in left side of chest

Fig.1. shows the contrast CT image in which we can see the presence of bowel loops in the thorax and obliteration of the left lung completely

Fig .2. x-ray chest of the patient which shows the presence of bowel loops in the left side of thorax and naso gastric tube in the thorax as stomach is herniated into thorax

Fig.3. CT Axial section showing bowel loops in left side of chest

Fig.3 showing the axial image in which there is lung shadow in the right side but few air fluid levels in the left side suggesting bowel loops in thorax.

Fig.4. CECT of chest showing collapsed left lung

Table no 2. Showing organ herniated into thorax, bowel perforation, and any other associated injuries

S. no	Organ herniated	Bowel perforation	Associated injuries
Case 1.	Stomach, transversecolon,jejunum,ileum,	Not present	Wing of Ileum fracture.pubic bone diasthesis
Case 2.	Stomach,transversecolon,spleen,jejunum, ileum	Not present	Left lung contusion
Case 3.	Stomach,transversecolon,jejunum,ileum, descending colon,	present	Left 4^{th} 5^{th} 6^{th} rib fracture
Case 4.	Left lobe of liver,pericardiumrupture,transverse colon	Not present	Sternum fracture
Case 5.	Left lobe of liver,transversecolon,stomach	present	No any other injuries

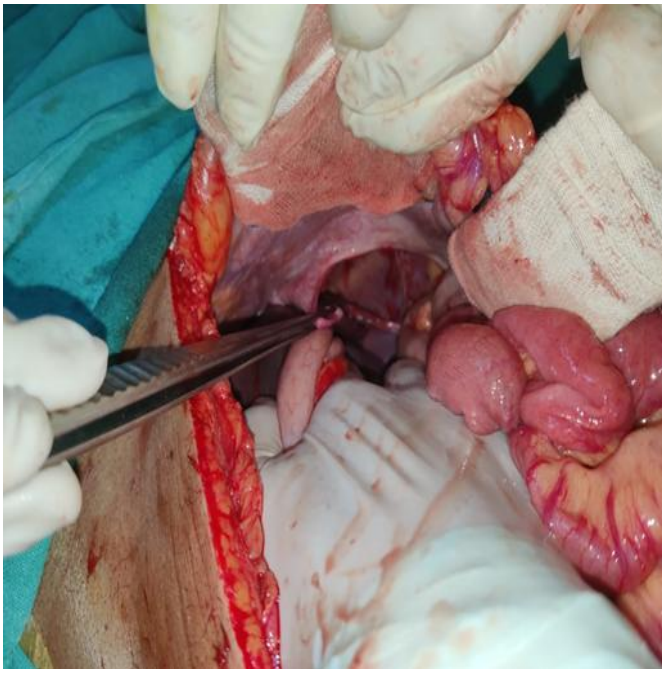

Fig 5. Intraoperative image showing the defect of diaphragm

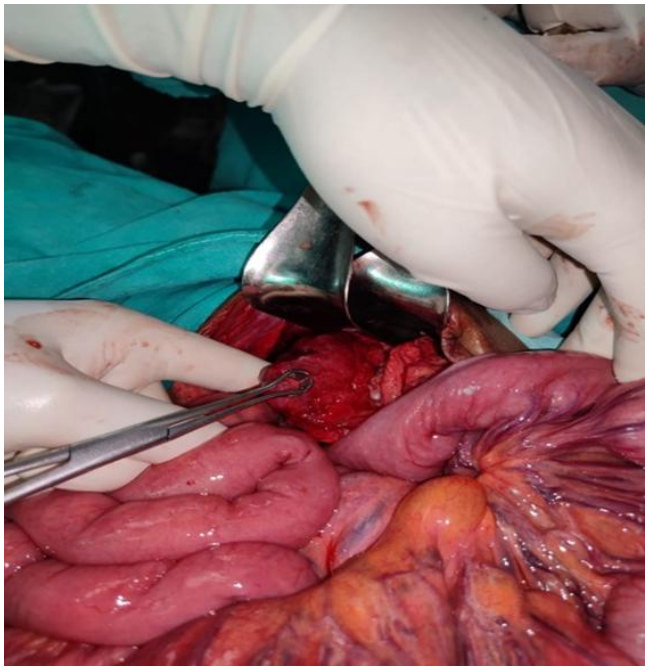

Fig 6.Organs being retrieved from the thoracic cavity into the abdominal cavity

Fig 5. Intraoperative image showing the defect in diaphragm through which the herniation occurred

Fig 6. Abdominal organs being retrieved into the abdominal cavity which herniated through the defect

Table no 3. Showing state of shock, requirement of intubation, and response to resuscitation

S. no	Preoperative shock	Requirement of intubation	Response to the resuscitation
Case 1.	No state of shock	No	Good responder
Case 2.	No state of shock	No	Good responder
Case 3.	Patient was in shock	No	Partial responder
Case 4.	Patient was in shock	No	Poor responder
Case 5.	Patient was in shock	yes	Poor responder

Out of the total 5 cases 2 patients were not in shock and 3 were presented in shock. 2 were good responders to resuscitation and 2 were poor responders to resuscitation. And 1 was partial responder initially (table no .3)

Table no 4. Showing procedure done, operation time, outcome of the case

S. no	Procedure done	Operation time	Outcome of the case
Case 1.	Exploratory laparotomy with repair of TDR with left sided chest tube insertion	2hr :15min	Survived and got discharged
Case 2.	Exploratory laparotomy with repair of TDR with left sided chest tube insertion	2hr:30min	Survived and got discharged
Case 3.	Exploratory laparotomy with repair of TDR with jejunojejunal RA with left sided chest tube insertion	3hr :30 min	Survived and got discharged
Case 4.	Exploratory laparotomy and thoracotomy with repair of TDR with pericardium repair with right sided chest tube insertion	3hr:55 min	Patient did not survive
Case 5.	Exploratory laparotomy and thoracotomy with repair of TDR with right sided chest tube insertion	3hr:15min	Patient did not survive

Fig 7. Intraoperative image post repair of diaphragm

Fig 7. Shows the repaired defect of diaphragm done with non absorbable polypropylene suture material

Exploration of abdomen was done in all cases and thoracotomy was done in two cases. The organ herniated into thorax were retrieved back into the abdominal cavity (fig 5,fig 6) and managed accordingly followed by which the defect in the diaphragm was repaired with non absorbable mono filament suture and no mesh was placed in any of the cases and ICD (intercostal drain) insertion was done in all the cases(Table 4).

Laparoscopic repair of TDR can be done if there is no any other organ injury associated with it. Hence, we had to do exploratory laparotomy and retrieval of abdominal content back to abdominal cavity with repair of TDR followed by an ICD insertion in all the cases and thoracotomy was done in 2 cases where there is right sided diaphragm tear and associated pericardial injuries.

Table no 5. Showing percentage of mortality morbidity and predictive factors for outcome of the patient

Mortality	Right TDR >left TDR	20% (overall mortality)
Morbidity	TDR associated with other injuries	60%
Predictive factors	**Positive predictive factors:** Left TDR, early time of diagnosis, good response to shock, no requirement of intubation, less operation time,	**Negative predictive factors:** Right TDR, late time of diagnosis, no/poor response to shock, requirement of intubation, more operation time

Out of total cases 2 were scummed to death and rest 3 were discharged after full recovery, and both the diseases patients were right sided TDR (Table 4,5.). If there are no any other associated injuries the patients with diaphragm rupture may remain asymptomatic for longer duration and may present late.

DISCUSSION

TDR is caused by thoracoabdominal trauma that is either blunt or penetrating. According to a large collective review, blunt trauma causes 75% of diaphragm injuries and penetrating trauma causes 25%.[7] In our study, 80% of TDRs occurred with blunt trauma, with traffic accidents being the most common cause of blunt trauma.

Most diaphragmatic ruptures in individuals with forceful abdominal injuries occur along the posterolateral side of the left diaphragm. This section, which is generated from the pleuroperitoneal membrane, is structurally the weakest. Due to the liver's ability to distribute pressure across a larger area, the right diaphragm is naturally stronger than the left. The reported rate of left-sided TDR, which stands after blunt trauma ranges from 68% to 87%.[7,8,9] Similarly, three (60%) of the five patients in our study had left-sided TDR.(fig 8)

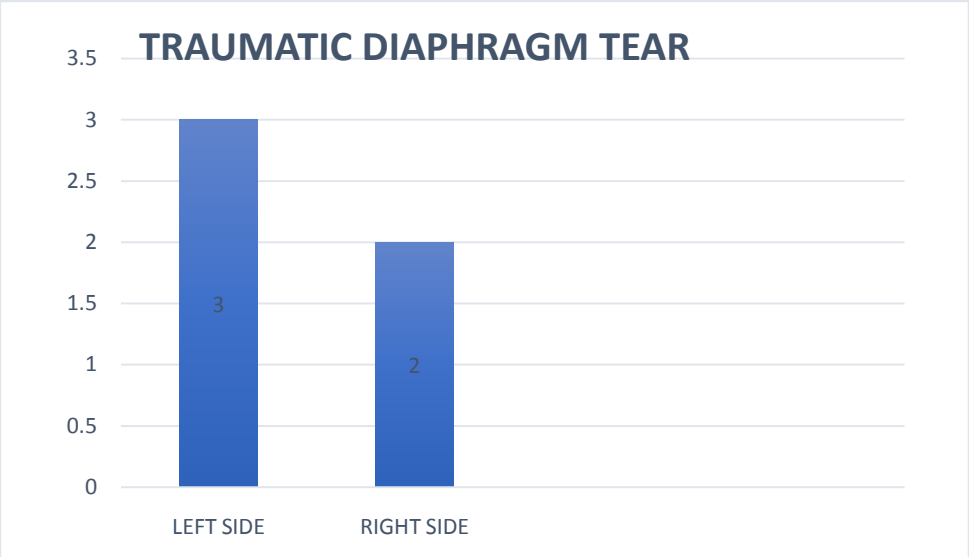

Fig 8. A bar graph showing the number of patients sustaining the TDR and the side of TDR

Because of the significant morbidity and fatality rates associated with this injury, patients with TDR require rapid surgical treatment.[9] Plain chest X-ray, upper GI contrast study, fluoroscopic measurement of diaphragmatic motion, ultrasonography, CT scan, laparoscopy, and video-assisted thoracic surgery have all been shown to be beneficial in the evaluation of TDR.

Chest X-ray and CT scans, the two most frequently used diagnostic modalities, are diagnostic in 30% to 50% of patients [10,11,12]. CT scans, on the other hand, have been shown to possess a sensitivity of 61% to 87% and a specificity that ranges from of 72% to 100% [11,12] and to be the best diagnostic modality in successfully revived stable patients.

We discovered that CT scans of the chest and upper abdomen had a sensitivity of 60% when evaluating patients at admission. whereas ultrasound of chest and abdomen has a sensitivity of 40% and x-ray of chest and abdomen when combined with USG combined has a sensitivity of 60% in diagnosis of the condition. (fig.9)

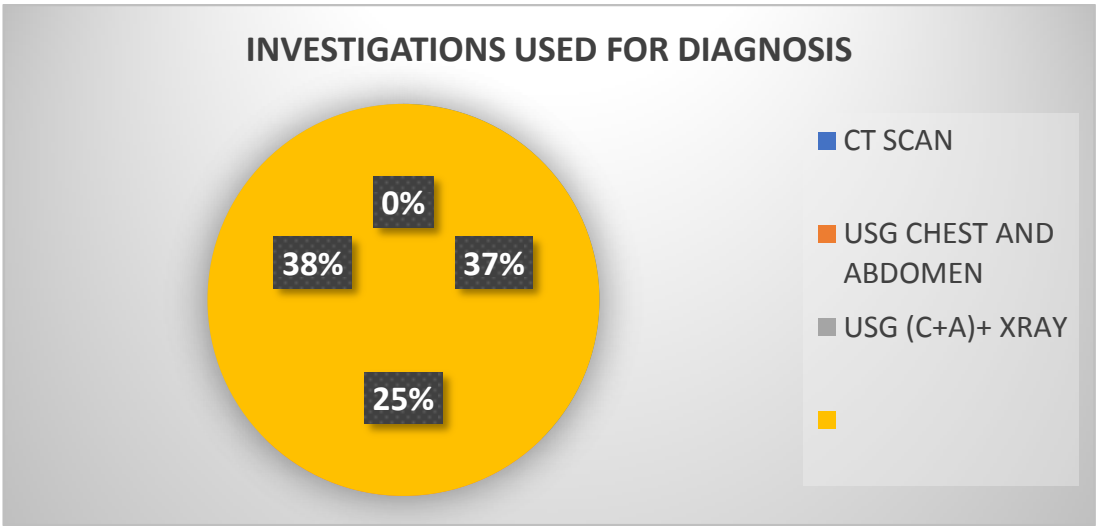

Fig 9. Pie chart showing the diagnostic modality being used in our study

However, the delayed diagnosis did not affect mortality, suggesting that TDR itself does not affect patient outcomes. The related injuries in the patients in our group matched those previously noted.[13] Patients with BTDR had rib fractures and abdominal solid organ injuries far more frequently than hollow viscus injuries. Despite several rib fractures, we also discovered that lung parenchymal laceration was uncommon. In addition, injuries to intra-abdominal organs (liver,40%; spleen, 10%) and hollow viscus perforation (1 patients, 20%) were more frequent than injuries to the lung parenchyma (1 patient, 20%), suggesting the necessity of intra-abdominal exploration in patients with BTDR. (Fig 10)

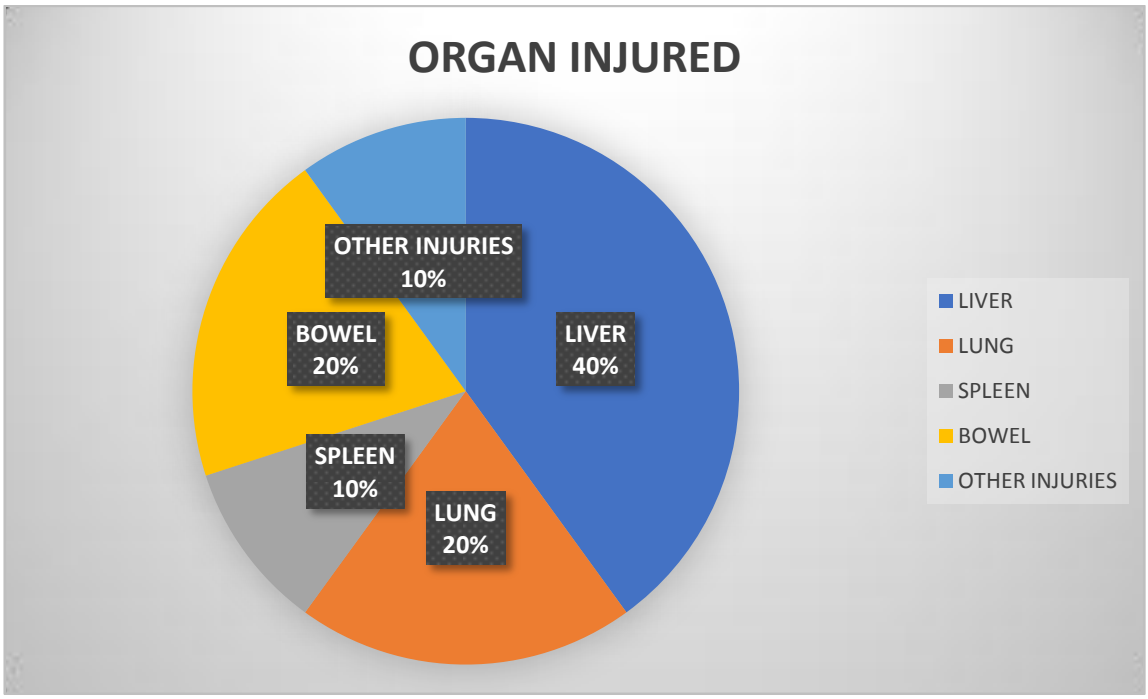

Fig 10. Showing the percentage of other organs injured in TDR

Thoracotomy as well as laparotomy are two surgical techniques that can be used. Patients with acute BTDR are advised to have laparotomies because they enable examination of the intra-abdominal organs for related damage. [7,14] For individuals with a chronic injury, a thoracotomy may be required to carefully separate adhesions between the pleura and the abdominal organs.[15].

Thoracotomies were performed more frequently before these concepts had been established at our hospital, and a lot of these patients required subsequent laparotomies to investigate intra-abdominal combination injuries.

Patients who had a thoracotomy rather than a laparotomy as their initial procedure had a higher rate of further exploration. Additional exploration was associated with a significantly longer operation time (215minutes (for thoracotomy) vs 163.33minutes (for laparotomy),) and a significantly higher morbidity rate (72.7% vs 22.2%,). These findings suggest that in patients with BTDR, laparotomy must be the first line of treatment.

CONCLUSION

Our experience and study shows that, in patients with Traumatic Diaphragm Rupture, intra-abdominal organ damage is more frequent than intrathoracic injuries, suggesting that laparotomy has to be the first treatment option when there is associated solid organ injury also, which can be dealt simultaneously

Preoperative shock and right-sided TDR are predictors of death after TDR. So, timely diagnosis and intervention can reduce the morbidity and mortality in patient with diaphragm rupture

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