

# Laparoscopic Diaphragmatic Repair: A Single-center Experience

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## ABSTRACT

**Background:** With the ongoing advances in the field of laparoscopy, more and more of diaphragmatic repairs are being performed laparoscopically. All forms of diaphragmatic pathologies, such as congenital diaphragmatic hernia (CDH) including diaphragmatic eventration, hiatus hernia as well as traumatic diaphragmatic rupture, can be well performed through laparoscopy. Laparoscopic repair along with the advantage of improved vision and accessibility can also avoid large incisions, thereby reducing morbidity and long hospital stay, due to pain and lung complications, with early return to work.

**Materials and methods:** A total of five cases underwent laparoscopic diaphragmatic repair at our center in 1 year duration. All cases were followed up with immediate postoperative and quarterly chest X-rays.

**Results:** None required conversion to open. Diaphragm was reconstructed and reinforced with mesh. None had any postoperative complications. Follow-up postoperative chest X-rays were unremarkable.

**Conclusion:** Laparoscopic diaphragmatic hernia repair is a feasible, acceptable, affordable, superior, and safe alternative to open repair with better short-term postoperative outcomes and a recurrence rate similar to the open approach.

**Keywords:** Congenital diaphragmatic hernia, Diaphragmatic eventration, Laparoscopy, Mesh repair, Minimal invasive, Traumatic diaphragmatic rupture.

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## INTRODUCTION

Among the various organs of the torso, diaphragm is a relatively rarely encountered surgical organ. Most common pathologies involving the diaphragm include congenital or acquired diaphragmatic hernias, diaphragmatic eventrations, hiatus hernia, and traumatic diaphragmatic rupture.

The congenital diaphragmatic hernias (CDHs) are usually reported in pediatric age-group with pulmonary complications. Asymptomatic neglected CDH is also in later age-group. In adults, traumatic rupture and eventration are relatively more common. Sudden elevation in the pleuroperitoneal pressure gradient<sup>1</sup> results in traumatic diaphragmatic rupture. Due to protective effect of liver,<sup>2</sup> underdiagnosis on the right side, and weak left hemidiaphragm at embryonic fusion points of pleuroperitoneal canals,<sup>1,3,4</sup> it is more common on the left side. Chronic, undiagnosed, or ignored rupture develops dense adhesions between the abdominal organs, sac, and pleura predisposing to incarceration as well as damage to contents during reduction.<sup>5</sup>

The average age of presentation in adults is 36 years, with a male preponderance (11:2).<sup>6</sup> It is more common on the left side (85%).<sup>7</sup> Most patients present with shortness of breath (SOB) on exertion, atypical chest pain, abdomen pain, or recurrent lung infections. Rarely may present with obstruction. Sometimes may be asymptomatic and incidentally detected or present with a history of blunt trauma. The contrast-enhanced computed tomography (CECT) abdomen is the most acceptable diagnostic tool.

Surgery is indicated for symptomatic<sup>8</sup> as well as asymptomatic patients who are fit for surgery.<sup>9-11</sup> Laparoscopy has superseded open repair as a standard of care.

Controversies in diaphragmatic hernia management include (1) management of hernia sac, (2) to close the defect or not, and (3) the choice of mesh.<sup>12</sup> Although the risk of seroma formation in

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the remnant sac is present, most surgeons prefer to leave the sac behind, due to the chances of pleural injury. A study of the 30-day postoperative CT scan showed complete disappearance of sac by 30th day.<sup>13</sup> No studies had proven superiority of interruption over continuous sutures or permanent over absorbable sutures.<sup>14</sup> Defects larger than 20 to 30 cm should be reinforced with appropriate mesh.<sup>11,15</sup>

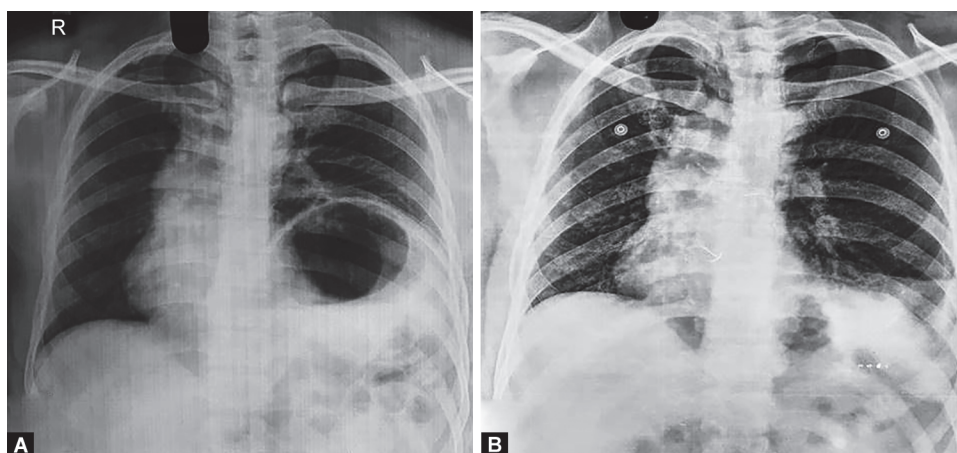
## MATERIALS AND METHODS

A total of five cases underwent laparoscopic diaphragmatic repair at our center in 1 year duration. Two were for left diaphragmatic eventration (Fig. 1), one for right Morgagni, one for left Bochdalek (Fig. 2), and one for left traumatic rupture (Fig. 3).

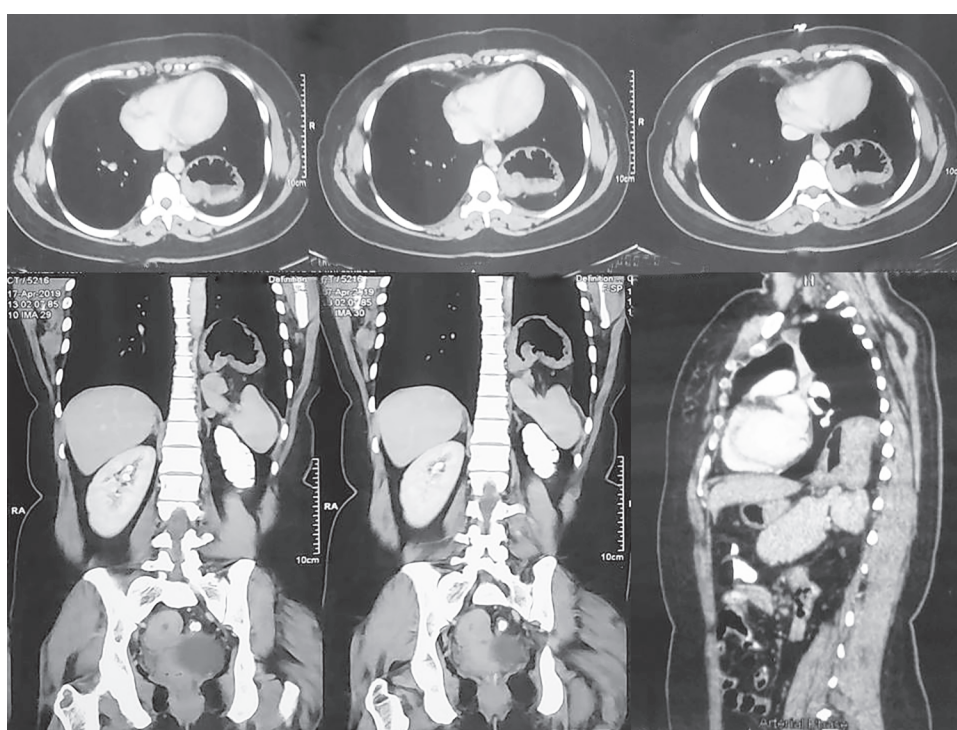
All cases were evaluated with preoperative chest X-ray and CECT abdomen.

## Operative Procedure

Under general anesthesia, with single lung ventilation, patients were kept in supine, leg split position with reverse Trendelenburg



**Figs 1A and B:** (A) Preoperative; (B) Postoperative chest X-ray of eventration



**Fig. 2:** The CECT abdomen image of Bochdalek hernia

tilt and sand bag under lower chest. Pneumoperitoneum created with Veress needle. Lower intra-abdominal pressure was used (10 mm Hg). A 10-mm umbilical port was used for camera with 30°/45° laparoscope and the remaining 5 mm ports placed as needed (Fig. 4).

For hernias, after reducing the contents, the sac was excised safely (Fig. 5). In the case of eventration, small rent was made in the thinned out diaphragm to create pneumothorax and reduce tension on diaphragm, the redundant thinned out sac was excised. Reconstruction done with barbed polydioxanone sutures (V-Loc) and reinforced with mesh. In the case of traumatic rupture, transmigrated abdominal contents were replaced in the abdominal cavity. Tension-free reconstruction was done with barbed PDS suture with interrupted ethibond sutures. The ICD was placed under vision before the defect closure (Fig. 6).

All cases were followed up with 1 week postoperative and quarterly chest X-rays.

## RESULTS

A total of five cases underwent laparoscopic diaphragmatic repair, and their characteristics are tabulated in Table 1.

The average age was 43.4 years (21 to 30 = one, 31 to 40 years = three, 71 to 80 years = one). Three of five cases were males (M:F = 3:2). Four of five cases were on the left side.

All cases presented with the chief complaint of shortness of breath on exertion, one case had a recent history of blunt trauma on the chest. None of the cases had features of obstruction.

Mesh placed in four of five cases. The ICD kept in four five cases and removed on the second postoperative day. None required conversion to open. Average operation time was 105 minutes. None

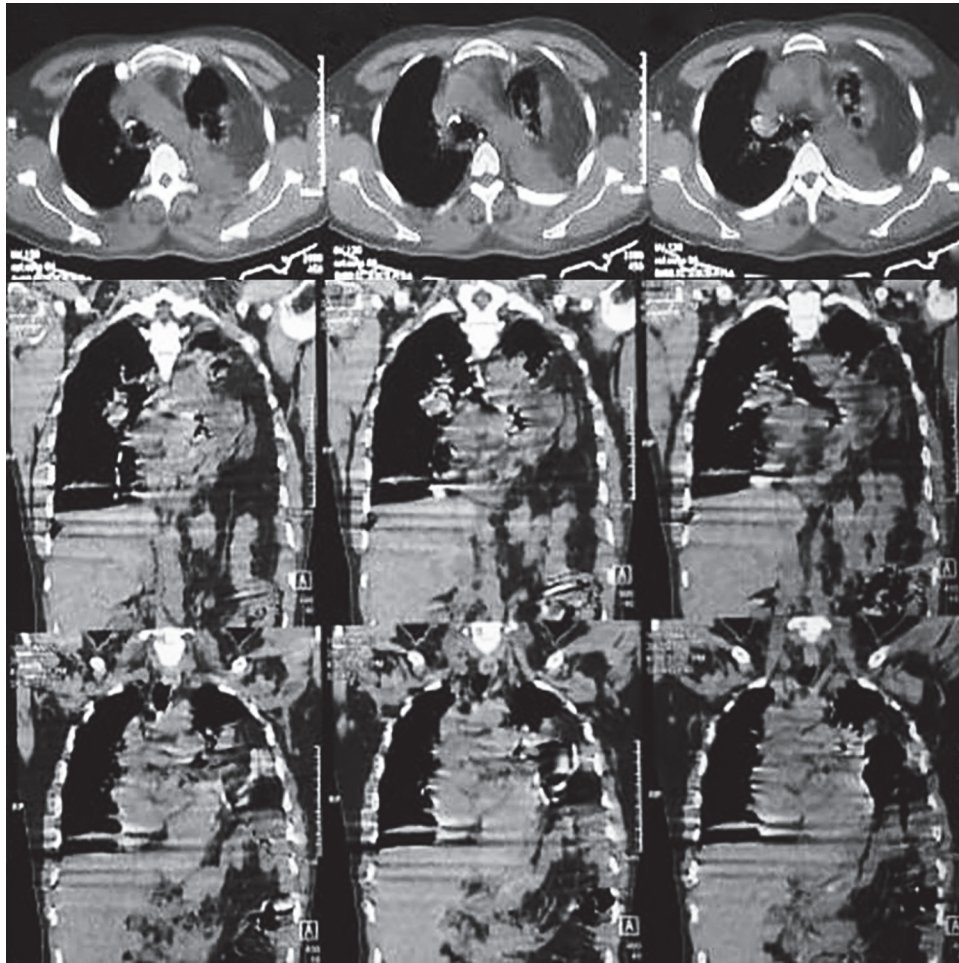


Fig. 3: The CECT abdomen image of diaphragmatic tear

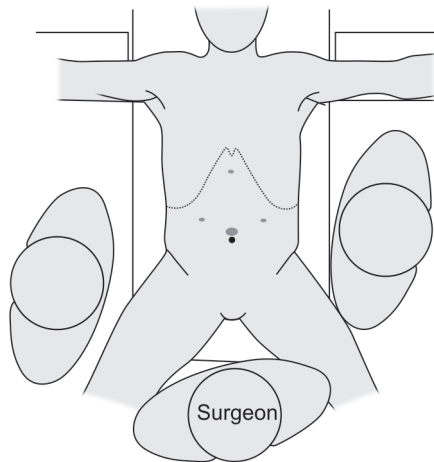


Fig. 4: Patient position and port system

has significant blood loss. The average postoperative pain score was 2.8. Average hospital stay was 3.8 days. None developed any postoperative complications. Follow-up postoperative chest X-rays were unremarkable.

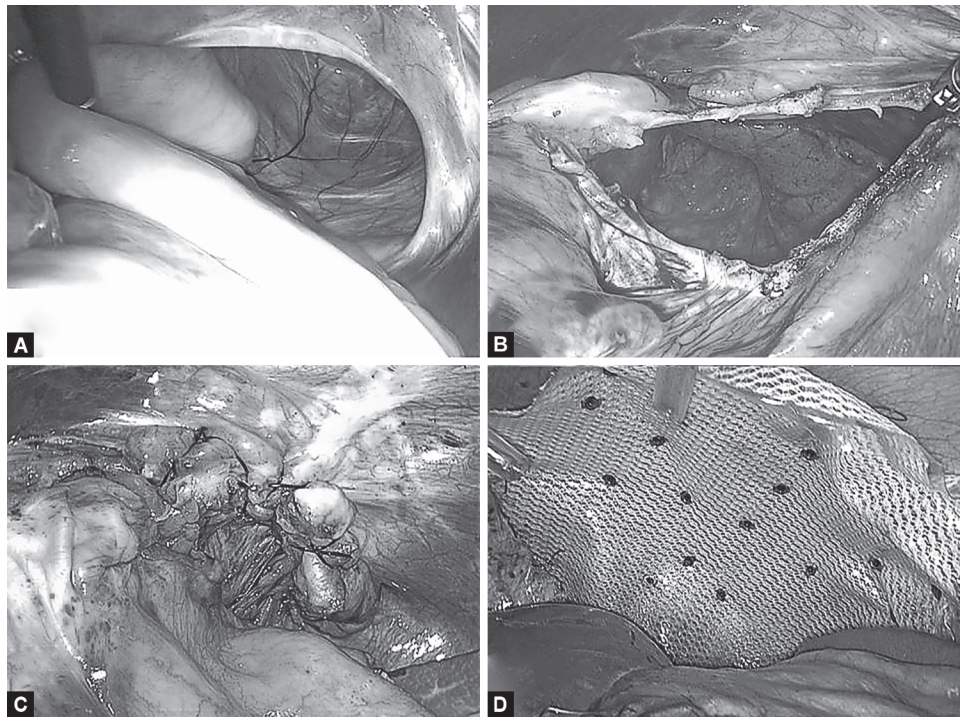
## DISCUSSION

Campos and Sipes<sup>16</sup> in 1991 and Kuster et al.<sup>17</sup> in 1992 reported the first laparoscopic diaphragmatic repairs. Ever since then, laparoscopic repair has increasingly been accepted as an alternative to open repair.

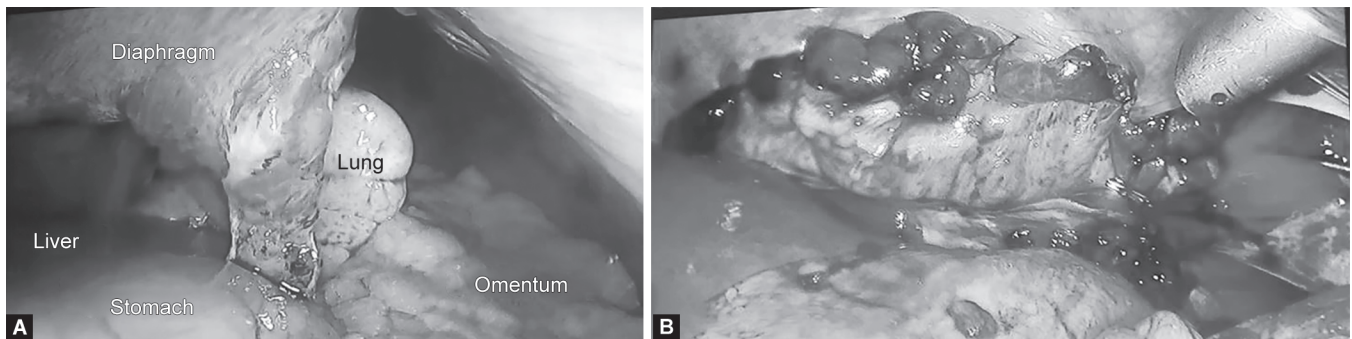
Open repair has disadvantages such as increased postoperative pain, long hospital stay, large incision and wound-related complications, pulmonary complications, and poor cosmesis.<sup>18</sup> Thoracoabdominal or thoracotomy approach showed increased incidence of ventilator requirement and increased incidence of deep venous thrombosis and pulmonary thromboembolism.<sup>19</sup>

Along with enhanced vision and better accessibility, laparoscopy has the advantage of less postoperative pain, faster recovery, shorter hospital stay (4.5 vs 5.9),<sup>19</sup> early return to work, decreased risk of wound complications, reduced morbidity, and good cosmesis. In our study, one patient (20%) had Bochdalek hernia. Palanivelu et al. reported 57%, Saroj et al. reported 30%, and Sharma et al. reported it as 62%. Among the various types of CDH, Bochdalek hernia is the most common type, but in adult population the percentages may be altered, compared to the pediatric group.

All cases (100%) had SOB on exertion as the presenting complaint, none had a history of recurrent pneumonias or any



**Figs 5A to D:** Intraoperative image of Bochdalek hernia: (A) Defect; (B) Sac dissected; (C) After repair; (D) After mesh placement



**Figs 6A and B:** Intraoperative image of diaphragmatic tear: (A) Before repair; (B) After repair

**Table 1:** Patient characteristics and data

	<i>Diagnosis</i>	<i>Age/sex</i>	<i>ICD</i>	<i>OT time</i>	<i>Postoperative pain score</i>	<i>Hospital stay</i>	<i>Postoperative complications</i>
1	Left traumatic diaph. rupture	38/M	+	120 minutes	4	4 days	Nil
2	Left diaph. eventration	39/M	-	105 minutes	3	3 days	Nil
3	Left diaph. eventration	35/M	+	120 minutes	2	3 days	Nil
4	Right Morgagni hernia	76/F	+	90 minutes	3	5 days	Nil
5	Left Bochdalek hernia	29/F	+	90 minutes	2	4 days	Nil
Avg.		43.4 years	4/5	105 minutes	2.8	3.8	Nil

features of obstruction. Sharma et al. reported that 60% cases had SOB and 40% had abdomen pain.

In the current study, average age was 43.4 years. Three of five cases were males. For four of the five cases it was on the right side, consistent with Saroj et al. whose average age was 36 years, M:F = 11:2 and Lt:Rt = 12:1.

All cases were evaluated with CECT abdomen, which is the most accepted imaging modality, particularly when the defect

size is small.<sup>20</sup> Approximately 38% of cases is misdiagnosed as pneumothorax, empyema, lung cyst, or pleural effusion, if CT scan is not done.<sup>21,22</sup>

In three of four hernia cases, neck of the hernia was wide and sac could be excised with ease (except in the case of Morgagni hernia, the mesh was placed in four of five cases (except in traumatic rupture), ICD in 4 of 5 cases, consistent with Palanivelu et al.<sup>12</sup> who quoted 85.7% meshplasty and 14 of 21 cases.

Average hospital stay was 3.8 days (3 to 5 days), consistent with Saroj et al.<sup>6</sup> who quoted a hospital stay of 4 days and Phillips et al.<sup>14</sup> quoted 4.5 days.

None of our cases had any postoperative morbidity or recurrence, consistent with Phillips et al.<sup>14</sup> who quoted modest postoperative morbidity and recurrence rates similar to open.

Laparoscopic diaphragmatic hernia repair is increasingly being reported to have better short-term postoperative outcomes<sup>19</sup> and a recurrence rate similar to the open approach.<sup>14</sup>

## CONCLUSION

Laparoscopic diaphragmatic hernia repair is an feasible, acceptable, affordable, superior, and safe alternative to open repair with better short-term postoperative outcomes and a recurrence rate similar to the open approach.

With regard to the controversies in diaphragmatic hernia management, at our center, we (1) excise thinned out diaphragm or hernia sac only when feasible and safe; (2) close the defect, without tension on the diaphragm, with barbed, continuous PDS sutures and interrupted ethibond sutures, wherever appropriate; (3) mesh reinforcement done in all cases of hernia and eventration, unless contraindicated.

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