

Laparoscopic Repair of Bochdalek Diaphragmatic Hernia in Adults

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Abstract

Bochdalek hernia (BH) is an uncommon form of diaphragmatic hernia. The rarity of this hernia and its nonspecific presentation leads to delay in the diagnosis, with the potential risk of complications. This review summarizes the relevant aspects of its presentation and management, based on the present evidence in the literature. A literature search was performed on PubMed, Google Scholar, and EMBASE for articles in English on BH in adults. All case reports and series from the period after 1955 till January 2015 were included. A total of 180 articles comprising 368 cases were studied. The mean age of these patients was 51 years (range 15-90 years) with a male preponderance of 57% (211/368). Significantly, 6.5% of patients were above 70 years, with 3.5% of these being above 80 years. The majority of the hernias were on the left side (63%), with right-sided hernias and bilateral occurring in 27% and 10%, respectively. Precipitating factors were noted in 24%, with 5.3% of them being pregnant. Congenital anomalies were seen in 11%. The presenting symptoms included abdominal (62%), respiratory (40%), obstructive (vomiting/abdominal distension; 36%), strangulation (26%); 14% of them were asymptomatic (detected incidentally). In the 184 patients who underwent surgical intervention, the surgical approach involved laparotomy in 74 (40.27%), thoracotomy in 50 (27.7%), combined thoracoabdominal approach in 27 (14.6%), laparoscopy in 23 (12.5%), and thoracoscopic repair in 9 (4.89%). An overall recurrence rate of 1.6% was noted. Among these patients who underwent laparoscopic repair, 82% underwent elective procedure; 66% underwent primary repair, with 61% requiring interposition of mesh or reinforcement with or without primary repair. The overall mortality was 2.7%. Therefore, BH should form one of the differential diagnoses in patients who present with simultaneous abdominal and chest symptoms. Minimal access surgery offers a good alternative with short hospital stay and is associated with minimum morbidity and mortality.

Keywords: Bochdalek hernia (BH), congenital diaphragmatic hernia (CDH), laparoscopic repair

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Introduction

Congenital diaphragmatic hernia (CDH) has an incidence of 1:2000-1:12,500 live births and accounts for 8% of all the major congenital anomalies.^[1,2] It is caused by the failure of diaphragmatic closure and usually presents in neonates with respiratory distress. It is associated with 40-50% mortality.^[1,2] The commonest CDH is Bochdalek hernia (BH). Adult presentation, however, is rare. The incidence is reported to be 0.17%, with the majority of hernias occurring on the left side.^[3] The diagnosis of

BH is often difficult to make in adults due to the wide variation in their presenting symptoms and the rarity of this hernial defect.^[1,4-8] Several factors that raise the intraabdominal pressure may predispose to it, with pregnancy being the most predominant.^[9-12] While most of these hernias are symptomatic and present with pain or complications such as strangulation,^[4,6,8,11,13,14] there are others that are detected incidentally during investigations for another cause.^[3,15] Unfortunately, some of these patients are misdiagnosed, leading to serious

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consequence.^[16-19] Historically these patients have been managed by laparotomy^[1,4,5,20-22] or thoracotomy,^[1,6,23] and primary repair with or without mesh reinforcement was performed. With the expansion of laparoscopic experience in various intraabdominal surgeries, there are several reports now of BH being successfully managed by a laparoscopic approach.^[4,7-10,24-28] This article reviews the literature with regard to the clinical features, complications, predisposing factors, investigations, various surgical approaches, and the feasibility and outcome of laparoscopic approach in patients with BH.

A search was conducted using PubMed, EMBASE, and Google Scholar for every case report, series, and literature review in English relating to BH in adults. Key words included were “congenital diaphragmatic hernia,” “Bochdalek hernia,” and “posterolateral hernia in adults.” All patients aged 15 years and above were considered as adults and were included in the study. The review extended from 1955 to January 2015. The data studied included demographic details, presenting symptoms, predisposing factors (including pregnancy), recurrent hernias, intraoperative findings, various surgical approaches, and laparoscopic surgical procedure and its outcome.

A total of 368 cases of BH were found among the 180 articles studied [Table 1]. Among these, 57% were males, with a mean age of 51 years (range 15-90 years). Eight among these (3.5%) were above 80 years and 7 (3%) were aged 70-80 years. The majority of the BHs were on the left side (63%), with the incidence of right-sided and bilateral hernias being 27% and 10%, respectively [Table 1]. However, one study with 142 cases had lacked some of the details; hence this study predominately deals with 226 cases from 179 articles. Among these 226 patients, precipitating factors was reported in 24%, 5.3% of them being pregnancy. In 11%, congenital anomalies were noted. The most predominant symptoms were abdominal (pain/discomfort) (62%); others included pulmonary symptoms (cough, chest pain, wheezing, infection; 40%), obstructive symptoms (abdominal distension, vomiting, obstipation; 36%), and strangulation (26%); 14% were asymptomatic [Table 2]. Among these 226 patients, 42 (18.8%) did not undergo any procedure (unfit for surgery, too old, or not willing for surgery). Among the remaining 184 patients who underwent surgical intervention, the approach included laparotomy [74 (40.27%)], thoracotomy [50 (27.7%)], combined thoracoabdominal approach [27 (14.6%)], laparoscopy [23 (12.5%)], and thoracoscopic repair [9 (4.89%)]. In those with laparoscopic repair, 82% had elective surgery, with 66% of them being primary repair. Interposition of mesh or mesh reinforcement was required in 61% of them. There was 9% morbidity

Table 1: Literature review (1955-2015) - Demographic details

Number of patients 368; Number of articles 180

Average age (years)	51
Range (years)	15-90
Male:female (number of cases)	211:157
Male:female ratio (%)	57:43
Patients >80 years*	8 (3.5%)
Patients 70-80 years*	7 (3%)
Right-sided	101 (27%)
Left-sided	231 (63%)
Bilateral	36 (10%)
Precipitating factors*	24%
Pregnant patients (overall)*	5.3%
Congenital anomalies* Situs inversus/liver hypoplasia/ vascular anomalies/ectopic kidney	11%

*Indicates data out of 226 adults from 179 articles. These do not include data from one article of 142 adults, as these aspects are not included in the article

Table 2: Presenting symptoms and the percentage (226 adults)

Presenting symptoms	Percentage (%)
Abdominal pain/discomfort	62
Pulmonary symptoms (cough/wheezing/pain/ infection)	40
Obstructive symptoms (vomiting/abdominal distension/obstipation)	36
Strangulation	26
Asymptomatic (detected incidentally)	14
Other symptoms (jaundice/cardiac failure/hypertension (systemic/pulmonary), fatigue, indigestion)	9
GERD	4
Dysphagia	3
Symptoms less than 1 month	43

GERD = Gastro-esophageal reflux disease

and no mortality in the laparoscopy group. The mean hospital stay was 4 days.

There was overall 2.7% mortality among all the operated cases; 4 deaths, 2 each in the laparotomy and thoracotomy groups. Among the pregnant patients, 58% were treated in the second trimester. The surgical approach for them included laparotomy and laparoscopy in 54.5% and 45.5%, respectively [Tables 3 and 4].

Embryological Cause

Embryologically, the development of diaphragm occurs during the fourth week of gestation, and by the sixth week the pleuroperitoneal folds on the lateral body wall grows medially to fuse with the septum transversum.^[1,4,29] The fusions of these two muscle

Table 3: Details of patients with laparoscopic approach^[9-12,53-62]

Details	Number of cases	Percentage (%)
Total number of cases	23/184	12.5
Diagnosis prior to surgery	17/23	74
Emergency surgery	4/22	18
Size of the defect (cm ²)	52 (N=15 cases)	–
Resection of hernia sac	2 (N=9 cases)	22
Primary repair	14/21	66
Interposition of mesh+	13/21	61
Complications	2/21	9.5
30-day hospital mortality	0/21	0
Hospital stay in days (mean)	4 (n=15)	–
Recurrence	0/23	–
Follow-up (mean 26 months)	17 cases	–

Table 4: Details of pregnant patients with BH hernia^[9-12,53-62]

Details	Number of cases	Percentage (%)
Pregnant patients	12/226	5.3
First trimester	2/12	16.6
Second trimester	7/12	58.3
Third trimester	1/12	8.3
Postpartum	2/12	16.6
Laparoscopic repair	5/11	45.4
With mesh	4/11	36.3
Laparotomy	6/11	54.5
No intervention	1	9.09
Emergency	7	58
Elective	5	42
Morbidity (mother)	3	25
Mortality	2	16
Fetal loss	3	25

^{*}Indicates data out of 226 adults from 179 articles. These do not include data from one article of 142 adults, as these aspects are not included in the article

groups, which occur at the final stage of development, are regions anatomically vulnerable to developing hernia.^[2,4] BH develops at around 8-10 weeks of gestation at this fibrous lumbocostal trigone, which is the junction of lumbar and costal muscle groups in the posterolateral diaphragm.^[2,4,29,30]

CDH has been classified into the following different types: Eventration of diaphragm, posterolateral hernia of Bochdalek (aka, BH), parasternal hernia of Morgagni-Larrey, pertioneopericardial hernia, and the central tendon hernias.^[1,2,4,7,29] BH, which was first described by Bochdalek in 1867, is the commonest of CDH and accounts for 95% of them.^[1,2] Unlike BH, Morgagni-Larrey hernia is usually asymptomatic in the neonatal period and may present in adulthood with incarceration.^[1,7,30] The defect occurs between the

attachment of the diaphragm to the xiphoid process and the seventh costal cartilage. The retroxiphoid space is termed “Larrey’s gap” on the left and “Morgagni’s gap” on the right side.^[1,2,7] Central diaphragmatic hernias are even rarer and involve the central tendinous (amuscular) portion of the diaphragm, with rest of the diaphragmatic musculature being normal.^[1,7,29,30]

Incidence and Prevalence

The prevalence of BH in one of the earlier reports (1985) was found to be 6% among the 940 adults studied.^[30] However, the incidence of BH in the 13,138 abdominal computed tomographic (CT) scans performed for various chest and abdominal symptoms was reported to be 0.17%.^[3] This is similar to other studies, which report an incidence of less than 1%.^[13,31] The reasons for the difference between the earlier studies and the later ones are related to selection bias and the possible inclusion of diaphragmatic bosselation due to poor CT resolution in the 1980s.^[3] There is a general belief, however, that the incidence of BH is much higher than they were reported earlier.^[3,31] This view is supported by two recent reports, where on review of multidimensional computerized tomography (MDCT) images used for the diagnosis of other chest and abdominal pathologies, asymptomatic BH was noted in 10.5% and 12.5% of these patients, respectively.^[13,32] The high incidence of BH in these studies has been attributed to the high clarity in the definition of structural abnormality and the present wide use of MDCT in routine practice.^[13]

Congenital Anomalies

Congenital anomalies were observed in 11% of the patients studied in this review. These include situs inversus,^[1] malrotation,^[33-36] incomplete attachment of the cecum,^[31] hepatic hypoplasia,^[37-40] bifid liver,^[41] pulmonary hypoplasia,^[37] Chilaiditi’s syndrome,^[42] Marfan syndrome,^[43] mitral/tricuspid valve prolapse,^[44] patent ductus arteriosus,^[45] pulmonary sequestration,^[45] Down’s syndrome,^[46] accessory lung lobe,^[47] congenital pulmonary blebs,^[48] asplenia, deafness, accessory diaphragm,^[49] aberrant systemic artery to right lobe, and anomalous pulmonary vein.^[50] In neonates, the pulmonary hypoplasia and pulmonary hypertension that BH is invariably associated with, along with persistent fetal circulation leading to respiratory failure, causes management problems.^[5,7] The repair of BH is generally carried out in the neonate period after there is a significant improvement in pulmonary function and reduction in pulmonary hypertension.^[7] Laparoscopic repair, however, is not a viable option in neonates because of

the risk of pneumoperitoneum in an infant who already has compromised respiratory function.^[7]

Clinical Details

BH is usually congenital, arising due to failed closure of pleuroperitoneal ducts.^[7,29,30] About 5-25% of these are diagnosed beyond 8 weeks of life,^[2,51] and about 5% are diagnosed in adults.^[1,7,29,30,52] These hernias can thus be acquired in adulthood due to reopening of these ducts following the initial extension of intraabdominal or perirenal fat.^[1] The demographics of BH are reported to differ between symptomatic and asymptomatic patients.^[4] While some have reported that the right-side defects are larger,^[14] others have found no difference in the size between the two sides, being 37 cm² versus 39 cm², respectively.^[4] Symptomatic BHs are usually left-sided and are less likely on the right side, possibly due to the caudate lobe of the liver compressing the right pleuroperitoneal canal, thus preventing right-sided herniation.^[1,4,7,30] Moreover, the right hemidiaphragm is fully formed embryologically before the left.^[29,30] The hernial contents include the colon (63%), stomach (40%), omentum (39%), and small bowel (28%). Uncommon contents may include the spleen, tail of pancreas, and the kidney.^[4] The right-sided contents are likely to be the liver, kidney, fat and occasionally colon.^[1,4,7] The left-sided content includes the stomach, small gut, colon, spleen, tail of pancreas, and kidney.^[1,4,7] However, in patients with asymptomatic BH, detected on reviewing the MDCT images performed for other conditions, omental fat as content was noted in 95.5% of the cases. This could possibly indicate the detection of the hernia at an earlier stage.^[13] The clinical symptoms of BH are frequently vague and nonspecific and include chest and/or abdominal symptoms.^[1,4,7] Moreover, they could be intermittent, as herniated viscera can spontaneously reduce, causing symptom regression.^[1,7,8] The majority of these patients in our review (86%) were symptomatic, with abdominal pain (62%) and pulmonary symptoms (40%) being the most commonest.^[4] Obstructive symptoms (abdominal distension/vomiting) were observed in 36% of the cases, with strangulation in 26% of them. The other symptoms (9%) with which these patients presented included fatigue, cardiac failure, hypertension, and jaundice. Dysphagia (3%), gastroesophageal reflux disease (GERD) (4%) were other uncommon symptoms.^[4,20] Nearly half of these patients presented acutely, with 43% presenting with symptoms for 1 month or less.^[4] Gastric volvulus and obstruction and strangulation of the small or large gut are potential complications, with morbidity in some series being reported in 32% of these cases.^[1,53] In addition, gastric reflux and pancreatitis have been noted.^[20]

Misdiagnosis

A significant number of these patients with BH are misdiagnosed due to a combination of the rarity of this condition in adults and the varied clinical presentation. The incidence of misdiagnosis has been reported to be 38%.^[5] The misdiagnosis includes hydropneumothorax, hemothorax, empyema, pleural effusion, and pneumonia.^[16-19] The consequence of misdiagnosis is a delay in appropriate management, leading to a potential risk of strangulation; some of these unfortunate patients, in whom an intercostal tube is inadvertently placed, could have serious consequences.^[4,16-19] In view of the risk of misdiagnosis, some have suggested to look for additional clues in patients who present with respiratory symptoms and are suspected to have BH.^[52] These include:

1. Abdominal or thoracic symptoms aggravated in the supine position;
2. Postprandial respiratory symptoms;
3. Gurgling sounds in the chest with bowel sounds heard on auscultation;
4. Radiographic abnormalities while supine; and
5. Abdominal symptoms aggravated by physical effort.

Precipitating Factors

Precipitating factors play a role in the manifestation of BH and have been reported in 25% of these patients.^[4] The prime factor is the rise in intraabdominal pressure and may be due to several causes, including persistent coughing/ chronic obstructive airway disease (COPD),^[37,38] vigorous physical activity, sneezing, chronic constipation,^[44] retching, large meals, diving, fits of laughter, pregnancy, and childbirth.^[9-12,52,54-59]

Association with Pregnancy

Overall, 5.3% of the adult patients with BH in our review were pregnant.^[9-12,54-62] Pregnancy has been found to be the most significant predisposing factor and is seen in 34% of cases where at least one precipitating factor is noted.^[4] The management of these patients and the timing of surgical repair with regard to the stage of pregnancy is debatable. In patients who are asymptomatic and are discovered to have BH incidentally during pregnancy, elective hernia repair during the second trimester is advised.^[9,33,62] In those patients who present with obstructive symptoms, surgical intervention is carried out irrespective of the stage of pregnancy because of the potential risk of strangulation and its deleterious consequence on both the fetus and the mother.^[62] For those that are detected in the third trimester, there are some who would induce labor once fetal maturity is reached and carry out the repair in the postpartum phase.^[11,62] There are others who discourage active labor to prevent further herniation

of the contents and recommend cesarean section and hernia repair simultaneously.^[61] In a review of 34 cases of diaphragmatic hernia in pregnancy (15 traumatic and 11 cases of BH), 66% underwent emergency surgeries, and of them 55% had strangulation.^[62] A fetal mortality of 26% (9/34) and maternal death of 14% (5/34) was noted.^[62] Only 2 of the maternal deaths were in BH patients and were in those who were treated before 1980. The risk of maternal and fetal mortality in patients with diaphragmatic hernia reflects the seriousness of this hernia in pregnancy and the need for its early identification and prompt treatment.

Recurrence Rate

This review notes recurrence in 3 out of 184 patients (1.6%) of the operated cases.^[62-64] The initial repairs in these patients were by open thoracic and thoracoabdominal approaches. In addition, the primary repair was reinforced with mesh. No precipitating factors to contribute to their recurrence were observed. The recurrence was repaired by laparotomy with mesh reinforcement (dual and polypropylene each).^[62-64] The difficulty encountered during the repair included dense adhesions to surrounding structures, including the pericardium. In addition, larger diaphragmatic defects were found. In 1 case there was a near absence of diaphragm, barring a rim of peripheral remnant, due to retraction of the diaphragm.^[63,64]

Investigations

An adequate preoperative and intraoperative assessment of the location and the size of defect are critical to the success of BH repair.^[3,4,7,8,32] The presence of air meniscus sign on chest x-ray should draw the attention of the clinician to this possible diagnosis. Further radiological investigations may be performed to confirm the diagnosis.^[65] BH is often difficult to appreciate on chest x-ray and a previous normal chest x-ray may not exclude BH, as the herniation of content may be intermittent.^[66,67] The role of CT as a diagnostic modality in establishing a preoperative diagnosis is well established^[68] [Figure 1]. The typical findings on a CT include the presence of fat or soft tissue over the upper surface of the diaphragm, characteristically posterolateral, a mass adjacent to the diaphragmatic defect and a continuous density over and under the diaphragm's discontinuity.^[30] However, a preoperative CT or magnetic resonance imaging (MRI) in the usual horizontal plane may not always enable the definitive diagnosis of BH, or reveal the details of the diaphragmatic defect. Hence a reconstructed three-dimensional section on CT or MRI images may be useful to detect the precise diaphragmatic defect and size.^[69,70] Of late, MDCT has further enhanced the detection rate



Figure 1: CT scan revealing herniated stomach through a left BH (arrows)

and clarity of diaphragmatic abnormality.^[13,32] MRI, too, distinctly reveals the discontinuity of the soft tissue lines in the diaphragm on both the sagittal and coronal planes.^[70]

Ultrasound has been reported as a useful initial tool in the work-up of suspected cases of BH.^[71] The features that would support the diagnosis include a fragmented diaphragm, inability to view the spleen and kidney within the same plane, and accordion-like spleen.^[71] In view of the association of congenital anomalies of the gut with the possibility of volvulus of herniated stomach, some recommend a barium series prior to surgical intervention.^[4] This is of particular importance if one were to consider thoracoscopic approach for repair.^[72] The presence of malrotation or volvulus would warrant an abdominal approach.^[4,7,68,73] Several other investigations may play a role in preoperative preparation of these patients, particularly in those with respiratory symptoms. These may include fluoroscopy, bronchogram, and pulmonary angiography.^[49]

Repair

The first successful surgical repair of BH was performed in 1901.^[61] Historically these patients were managed either by an open transabdominal or by a transthoracic approach. However, with the expansion of laparoscopic^[4,7-10,12,24-28] and thoracoscopic^[74-85] expertise and advances in instruments, the minimally invasive approach has emerged as an attractive option. There are, however, several areas of debate and these include the following:

1. Should all patients with BH be operated irrespective of whether they are symptomatic or asymptomatic (detected incidentally on investigations);
2. Should it be an open or laparoscopic/thoracoscopic approach;

3. Should the sac be excised;
4. Should a mesh be used to reinforce the repair, and if so, when; and
5. The method of fixation of mesh.

Most agree that all fit patients who are symptomatic and even those who are asymptomatic and detected incidentally should undergo surgical repair.^[1,5,8,10,12,27,60] The argument in favor of such an approach is that a significant number of these patients present acutely with serious complications such as strangulation of the gut, leading to severe morbidity and mortality.^[4,12,27,61]

The approach to repair of BH depends on the presentation (emergency or elective), size and side of the defect, and the presence of complications.^[4,5,8,10,76-80] For emergent cases, laparotomy is the favored approach, using either a midline or subcostal, or in difficult cases a thoracoabdominal, incision.^[4,7,8,41,79] This achieves better visualization of diaphragm on the left side and on the right side; the same is achieved following the mobilization of the right lobe of the liver.^[1,81-82] Laparotomy has the advantage of identifying the position of the viscera after the “pull back” of hernia content and repairing the malrotation, if any.^[1,50] Dissection of the sac is associated with a high risk of pleural injury and hence most of the surgeons prefer to leave the hernia sac in place.^[23,27] The development of a seroma in the remnant sac is a potential risk; however, it has been reported that the remnant sac completely disappears 30 days following surgery.^[83]

The superiority of thoracotomy, however, lies in separating the herniated organs from the thoracomedial viscera under direct vision before “push back” of contents is performed.^[21,22,62] A combined thoracoabdominal approach is undertaken in difficult cases, where a large volume of hernia contents is noted and when dense adhesions are expected, as in recurrent hernias.^[6,18,62,84] Small defects are easier to repair, whereas larger defects may involve the reduction of a large amount of intraabdominal contents.^[1,4,7,8,10] The defect is usually repaired along a “transverse axis” and may require the use of mesh in the absence of contamination.^[4,82] There are no data favoring interrupted over running sutures, permanent over absorbable, or two-layer over single-layer closure.^[6] Generally, nonabsorbable braided sutures in either interrupted or continuous fashion is advocated, based on the size and location of the defect.^[6] Suturing the defect is important for the restoration of the anatomy between the thoracic and abdominal cavities.^[4,23,24,82]

The mesh reinforcement of the repair depends on the defect size. While there are some who recommend the use of mesh for a defect larger than 20-30 cm,^[28] there are others who use it in defects of 8 cm size^[5,27] or when the

defect is more than 25 cm².^[86] Many surgeons prefer to repair most hernias with prosthetic graft reinforcement because of the continuing stress on the diaphragm that results from respiratory movements and cardiac motions.^[23] The use of mesh to a certain extent may achieve a tensionless repair of the defect.^[23] A primary closure may not be possible in 53% of the cases and hence those cases will obviously require repair with mesh.^[87] Many types of mesh are available for use in these types of repair. Polypropylene mesh has the benefit of providing indefinite support and excellent tissue growth. However, the concern of erosion of the mesh into the gastrointestinal organs represents a theoretical risk.^[23] The decreased tendency for adhesion formation between polytetrafluoroethylene and other types of dual mesh make them more desirable.^[23,26,27] Fixation of prosthesis can be achieved by intracorporeal suture or mechanical fixation devices such the endostaplers.^[27] Surgeons should take great care during the fixation of mesh with laparoscopic tacker where the diaphragm is relatively thin and in close proximity to the pericardium.^[23] Following surgery, while some would place an intercostal drainage tube to drain the chest,^[61,85,88-93] others would manage with transabdominal suction catheter to evacuate the thorax, just before deflation of the abdomen following the repair.^[4]

Laparoscopic Repair

Usually, a minimally invasive technique is used in an elective setting, though rarely for emergency cases. A laparoscopic approach was used in 82% of elective cases in our review. Laparoscopic repair is carried out by some, by placing the patient in lateral decubitus, reverse Trendelenburg position,^[4,93,94] while others would perform the procedure with the patient in the supine position.^[23,26,27] The lateral decubitus position has been reported to be particularly beneficial in pregnant patient undergoing BH repair.^[62] A 30-degree or 45-degree scope is desirable for adequate visualization of the diaphragm and the defect.^[6] While the laparoscopic approach is avoided in the presence of strangulation, there are reports of such surgeries being carried out in patients with incarcerated hernias, following the opening up of the diaphragm defect radially to reduce the viscera.^[23,25] Patients with gangrenous gut would require extensive resection of hernia contents and reconstruction.^[25,95] Minimally invasive techniques have been reported to result in reduced morbidity and might also improve the ease of hernia reduction, hemostasis, and adhesiolysis^[5,7,8,23-25,67] [Figure 2]. The distinct advantages of laparoscopy noted in this review are low morbidity (9%), no mortality, and short hospital stay (of 4 days). There has been a constant increase in

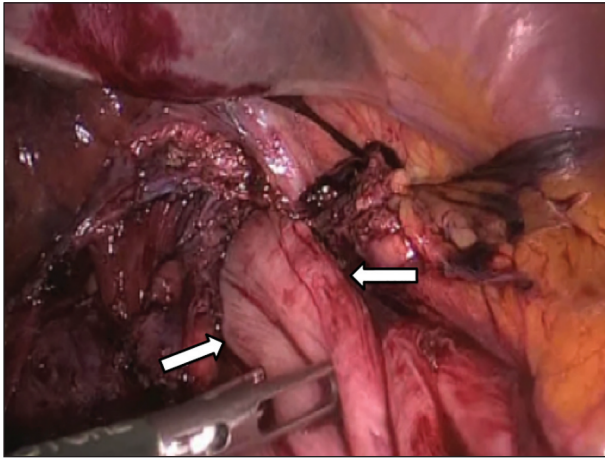


Figure 2: Laparoscopic view of reducing the herniated stomach from the chest in a patient with left BH (arrows)

cases where the laparoscopic approach was opted for in the management of BH in recent years.^[4]

The thoracoscopic approach for the repair of BH has been advocated by some.^[74-76] The distinct advantages of this approach are that it is minimally invasive and allows for the release of adhesions between the herniated viscera and thoracomediastinal structures under direct vision, before reducing them into the abdominal cavity.^[74-76] The thoracic cavity and the herniated organ can be examined in detail for ischemic changes, necrosis, or perforation before reduction. Moreover, repair of the hernia on the right side will be relatively easier, as the liver would not be obscuring the view.^[74] The concern, however, is that it may be difficult to manipulate the herniated organs into the abdomen, and in case of the spleen there may be a potential risk of bleeding while doing so.^[73,74] The reduction is facilitated by the reverse Trendelenburg position and CO₂ insufflation into the thoracic cavity.^[74] The abdominal cavity is inspected through the defect by thoracoscope to ensure safe placement of the herniated organ without malrotation.^[79] Some patients undergo minithoracotomy for placement of mesh.^[74-76]

Due to the absence of randomized controlled studies comparing the thoracic and abdominal approaches and the open and minimally invasive approaches, the choice of repair is left entirely to the individual surgeon's discretion. This choice is influenced by his/her past experience with minimal access surgery and the circumstances under which the surgery is performed (elective or emergency),^[23] and by the presence of complications. Preferably, surgical repair is performed in an elective setting and is the treatment of choice. This is reflected in the results, e.g., in one series, while the mortality of elective surgery was 5%, that following emergency surgery was significantly higher at 32%.^[83]

Intraoperative and Postoperative Complications

Pneumothorax has been recognized as a potential complication during laparoscopic diaphragm defect repair.^[6] Laparoscopic repair of traumatic diaphragmatic injury presents the greatest risk, with a reported risk of tension pneumothorax in 0.8% of the cases.^[94] Usually when present, the symptoms of pneumothorax are minimal and can be dealt with by lowering the insufflation pressure and adding positive end-expiratory pressure.^[6] Patients with persistent pneumothorax would need intercostal tube insertion in the postoperative period.^[6] The risk of pneumothorax, however, is minimal in patients with chronic diaphragmatic hernia, possibly due to the presence of intrathoracic adhesions and the presence of sac.

Potential complications also include injury to gut including perforation and bleeding while reducing and handling an oedematous gut.^[95,96] Moreover disruption of the spleen with bleeding or injury to the tail of pancreas during manipulation could also result.^[74]

If large hernias are reduced, it is crucial to monitor postoperatively for abdominal compartment syndrome (ACS).^[21] A firm tense abdomen, increased peak inspiratory pressure, and oliguria in the immediate postoperative period should raise concerns.^[21] In one such patient who underwent BH repair for incarcerated hernia, ACS in the postoperative period was complicated with empyema, gastropleural fistula, and sepsis, requiring multiple surgeries and a hospital stay of 11 months.^[21] Among the long-term complications, gastroesophageal reflux has been reported to be a potential complication after CDH repair.^[97,98] The role of antireflux procedure during the repair of hernia in these patients, however, is debatable.^[26,97,98]

The overall 30-day mortality was 2.7% (2% among the patients who underwent laparotomy^[4] and 5% of the patients who underwent thoracotomy), and there was no reported mortality among the patients who underwent thoracoscopic or laparoscopic repair.^[4] This may reflect selection bias, as the more complicated cases would have undergone an open approach.

Conclusion

BH is an uncommon form of diaphragmatic hernia. The recent literature, however, indicates a slightly increased prevalence of BH, with most being asymptomatic. It is pertinent for clinicians to be aware of this entity, particularly in patients who present with combined abdominal and thoracic symptoms. CT and MRI are

useful diagnostic tools. Pregnancy is a significant predisposing factor and when BH is found incidentally in pregnant cases, it may warrant an elective repair, preferably in the second trimester. A significant number of these patients present acutely with complications. While in the past an open approach with primary repair and mesh reinforcement was the norm, there is a constant increase in the reports of these being performed laparoscopically, with the associated well-established benefits.

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Conflicts of interest

There is no conflict of interest in publishing this article.

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