

# Repair of diaphragmatic hernias: Retrospective analysis of 70 cases

Osman Köneş, M.D., Ozan Akıncı, M.D., Sezer Bulut, M.D., Burak Atar, M.D.,  
Mahmut Said Değerli, M.D., Mehmet Karabulut, M.D.

Department of General Surgery, Bakirkoy Dr Sadi Konuk Training and Research Hospital, İstanbul-Türkiye

## ABSTRACT

**BACKGROUND:** Congenital and traumatic diaphragmatic hernias (DH) can lead to respiratory and gastrointestinal complications that can be the cause of serious morbidity and mortality. In this study, we aimed to share our experience with the surgical repair of complicated or non-complicated DH.

**METHODS:** Patients who were operated on under emergency or elective conditions with the diagnosis of DH between 2009 and 2023 were analyzed retrospectively. Demographic characteristics, histories, symptoms, etiology of DH, computed tomography findings, surgical techniques, and postoperative outcomes of the patients were recorded.

**RESULTS:** The mean age of the cases was  $51.5 \pm 18.5$ , and 29 were female and 41 were male. Hernia etiology was found to be congenital (40%), traumatic (32.8%), spontaneous (14.3%), and iatrogenic (12.8%), respectively. The mean diameter of the defects was  $7.3 \pm 2.76$  cm (range: 3–15 cm), and 84% of the defects were on the left side. Sixty percent of the cases were treated by laparoscopic surgery and 11.4% by laparotomy. The conversion rate from laparoscopic to open was 24.3%. Dual mesh was used in 48% of the patients, and primary suturing was applied in 34%. The postoperative mortality rate was 7.1%.

**CONCLUSION:** DH is an important cause of morbidity and mortality due to abdominal organ strangulation and pulmonary and cardiac complications. When a DH is diagnosed, laparoscopic or open surgery is the treatment that should be preferred.

**Keywords:** Congenital diaphragmatic hernia; diaphragmatic rupture; emergency surgery; mesh.

## INTRODUCTION

Diaphragmatic hernia (DH) is the protrusion of abdominal contents into the chest cavity due to a defect in the diaphragm. Congenital hernias are often observed in etiology, but they can also develop acquisitively. It has been reported that it affects 0.8–5 people out of every 10,000 births.<sup>[1]</sup> Congenital DHs range from asymptomatic cases to severe respiratory or gastrointestinal symptoms and sometimes hemodynamic instability.

Most of the acquired DHs occur as a result of diaphragmatic rupture, which develops secondary to blunt or penetrating trauma and is accompanied by herniation of the abdominal

contents. Traumatic diaphragmatic rupture is a rare complication that occurs in about 5% of all trauma cases, including vehicle accidents.<sup>[2]</sup> Acquired DHs can also develop iatrogenically or spontaneously. Although the frequency of acquired DHs is low, the mortality rate may result in up to 31% incarceration and strangulation.<sup>[3]</sup>

Although diagnosis is difficult, especially in traumatic DHs, emergency surgery may sometimes be necessary due to the fact that complications can lead to high morbidity and mortality. For the past decades, primary suture repair or closure of the defect with a synthetic mesh has been standard procedure. Recently, biological meshes have been shown to be effective in closing the defect. While traditional methods such

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Address for correspondence: Ozan Akıncı, M.D.

Department of General Surgery, Bakirkoy Dr Sadi Konuk Training and Research Hospital, İstanbul, Türkiye

E-mail: ozanakinci1987@hotmail.com

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as laparotomy and thoracotomy are still used, laparoscopic repair has grown in popularity in recent years.<sup>[4]</sup>

In this study, it was aimed at sharing the experience of a surgical unit on the repair of congenital and traumatic DHs.

## MATERIALS AND METHODS

Patients who were operated on under emergency or elective conditions with the diagnosis of DH in our clinic between April 2009 and June 2023 were analyzed retrospectively. Ethics committee approval was obtained for the study (approval number: 2023-14-16). Patients with DH secondary to thoracoabdominal blunt or penetrating trauma and patients with iatrogenic and congenital DH were included in the study. Patients who were operated on for hiatal hernia were excluded from the study. Patients who met the criteria for inclusion in the study were enrolled in the study (n=70).

Demographic characteristics, histories, symptoms, computed tomography (CT) findings, and surgical techniques of the cases were recorded. The etiology of the diaphragmatic defect, the diameter and localization of the defect, the presence of organ herniation, the length of hospital stay, complications, morbidity, and mortality rates were evaluated. CT was used for preoperative diagnosis in all patients. Mortality was defined as disease-related deaths within the first 30 days after surgery.

### Statistical Analysis

A descriptive statistical analysis was performed. The mean and standard deviation for continuous variables, percentiles, and numbers for categorical variables were calculated. Inferential statistical analysis could not be performed because there was no group comparison.

## RESULTS

The mean age of the cases was 51.5±18.5 (18–85), and 29 were female and 41 were male. Hernia etiology was found to be congenital (40%), trauma (32.8%), spontaneous (14.3%), and iatrogenic (12.8%), respectively. Seventy-eight percent of congenital hernias were Bochdalek hernias. The most common cause of traumatic DHs (n=13, 56.5%) was penetrating injuries. The most common cause of iatrogenic DHs was diaphragmatic rupture secondary to fundoplication surgery for gastroesophageal reflux (n=6). Most of the cases had respiratory (64.2%) and gastrointestinal (54.2%) symptoms (Table 1).

Forty-three percent of the patients underwent emergency surgery due to trauma or incarceration. Two cases had respiratory arrests during emergency admission and were operated on urgently. The mean diameter of the defects was 7.3±2.76 cm (range: 3–15 cm), and 84% of the defects were on the left side. From the abdomen to the thorax, the most common herniated organs were the omentum, stomach, colon, and small intestine, respectively (Table 2). The spleen in three cases and the left lobe of the liver in one patient were herniated into the thoracic cavity. 60% of the cases were

**Table 1.** Demographic, clinical characteristics of patients and etiological distribution of hernias

	n (%)
Age*	51.5±18.5
Gender (Female/Male)	29 (41.4)/41 (58.6)
Symptoms	
Respiratory (dyspnea, chest pain)	45 (64.2)
Gastrointestinal (abdominal pain, nausea-vomiting)	38 (54.2)
Etiology	
Kongenital	28 (40.0)
Bochdalek	22 (31.4)
Morgagni	6 (8.6)
Trauma	23 (32.8)
Penetran	13 (18.6)
Blunt	10 (14.3)
Iatrogenic	9 (12.8)
Spontaneous (idiopatic)	10 (14.3)
Site of defect (Left / Right)	59 (84.2)/11 (15.7)
Hernia diameter (cm)*	7.3±2.76

\*mean±SD

**Table 2.** Surgical data of the patients

	n (%)
Emergency surgery	30 (42.9)
Elective surgery	40 (57.1)
Hernia content	
Omentum	55 (78.6)
Stomach	42 (60.0)
Colon	24 (34.3)
Small intestine	10 (14.3)
Spleen	3 (4.3)
Liver (left lobe)	1 (1.4)
Surgical technique	
Laparoscopic	42 (60.0)
Conversion to open method	17 (24.3)
Laparotomy	8 (11.4)
Laparotomy+thoracotomy	3 (4.3)
Repair method	
Primer sütürasyon	24 (34.3)
Polypropylene mesh	12 (17.1)
Dual mesh	34 (48.6)
Other organ resection	6 (8.6)

treated by laparoscopic surgery and 11.4% by laparotomy. The conversion rate from laparoscopic to open was 24.3%

**Table 3.** Clinical outcomes of the patients

	n (%)
Length of hospital stay (days)*	4.97±3.00
Postoperative Complications	6 (8.6)
Mortality	5 (7.1)

\*mean±SD

(n=17). In three cases, thoracotomy was performed in addition to laparotomy. Dual mesh was used in 48% of the patients, and primary suturing was applied in 34% (Table 2). Due to the detection of strangulation, segmental colon resection was performed in 3 cases, and partial gastric resection was performed in 3 cases. The postoperative mortality rate was 7.1% (Table 3). The mean follow-up period of the patients was 81.6±35.16 months. Recurrent hernias developed in only two cases.

## DISCUSSION

DHs are of particular value to surgeons due to their high morbidity and mortality. Congenital DHs can be diagnosed prenatally or in the neonatal period. Therefore, the incidence is higher in children. On the other hand, congenital DHs seen in adulthood are less common and may arise from the anterior parasternal foramen of Morgagni or a primarily left-sided posterolateral defect called a Bochdalek hernia.<sup>[4]</sup> Posterolateral hernias (Bochdalek hernia) are the most common congenital type (>80%) and most occur on the left side. (85%). The severity of the disease in patients with congenital DH depends on the degree of pulmonary hypoplasia and pulmonary hypertension.<sup>[5]</sup>

Traumatic DHs are hypothesized to be caused by a rapid increase in the pleuroperitoneal pressure gradient at possible weak sites along embryological fusion points.<sup>[6]</sup> Traumatic DHs are often caused by penetrating injuries (10–19%) and sometimes by blunt thoracic-abdominal traumas (5%).<sup>[4]</sup> It has also been reported in the literature that it may develop secondary to pregnancy, sarcoidosis, Marfan's syndrome, colonoscopy, and heterotopic endometriosis.<sup>[7-11]</sup> More than 80% of congenital and traumatic DHs occur on the left side of the diaphragm.<sup>[12,13]</sup> This tendency is probably due to the protection of the right hemidiaphragm by the liver below it. In our study, 84% of the cases originated from the left side, which is consistent with the literature. In penetrating traumas, the defect in the diaphragm is smaller than in blunt traumas. Therefore, the risk of intestinal obstruction and strangulation is higher in penetrating traumatic DHs. In our study, all six cases of strangulation were DH secondary to penetrating trauma.

Traumatic diaphragmatic injuries are difficult to diagnose in emergency settings unless they are already accompanied by herniation of the intra-abdominal contents. Studies by Sarita et al. and Lu et al. reported that 64-slice multidetector CT (64-MDCT) can allow better visualization of the most subtle

signs of diaphragmatic damage with high sensitivity, specificity, and accuracy.<sup>[6,14]</sup> Early diagnosis of traumatic DHs can prevent morbidity and mortality from abdominal organ strangulation and respiratory complications. In missed and delayed traumatic DHs, surgery is mandatory as soon as possible in order to avoid complications. For these reasons, surgeons should have a high suspicion of diaphragmatic rupture in patients with thoraco-abdominal injuries. In our clinic, we perform diagnostic laparoscopy for DH in penetrating thoraco-abdominal injuries, in cases with blunt trauma with suspected isolated diaphragmatic injury and with signs of diaphragmatic defect on CT, in the presence of hemodynamic stability, in the first 48 h after trauma.

Iatrogenic DH is a rare complication of abdominal surgery and was reported to occur after gastric banding, total gastrectomy, nephrectomy, and adrenalectomy in the few cases previously reported.<sup>[15-18]</sup> Multiple factors may result from iatrogenic causes, depending on the type of surgery, patient-related factors, and technique used to close the diaphragm. Grasping the diaphragm, dissecting close to the diaphragm, and using an electrocautery can cause DH after surgery.

There are numerous large series describing DH repair via laparotomy, thoracotomy, laparoscopy, or thoracoscopy.<sup>[4,19,20]</sup> In recent years, there have been reports reporting robotic transabdominal and transthoracic DH repair in elective cases.<sup>[21,22]</sup> Conventionally, an open abdominal approach and primary closure are used. However, repair with polypropylene or dual-layer mesh is a safe alternative in cases where the size of the defect is too large to be closed with non-absorbable sutures or in cases of severe tissue loss. Recently, dual mesh has been preferred over synthetic mesh due to its lower hernia recurrence rate, higher resistance to infections, and lower risk of displacement.<sup>[4,23]</sup> In the presence of intestinal contamination, autologous flaps such as the omentum or latissimus dorsi are recommended instead of mesh.<sup>[24]</sup> We used dual mesh in 48% of the cases in our study. In our clinic, in parallel with the innovations in current surgery, all of the patients who were repaired with dual mesh were operated on within the last 10 years.

## CONCLUSION

DHs are an important cause of morbidity and mortality due to abdominal organ strangulation and pulmonary and cardiac complications. Early diagnosis of diaphragmatic injuries is very important to prevent delayed traumatic DH and complications. Treatment is open or laparoscopic surgery as soon as possible. Thanks to the developing technology, repair with biological meshes is safe and successful.

**Ethics Committee Approval:** This study was approved by the Bakirkoy Dr Sadi Konuk Training and Research Hospital Ethics Committee (Date: 17.07.2023, Decision No: 2023-14-16).

**Peer-review:** Externally peer-reviewed.

**Authorship Contributions:** Concept: O.K.; Design: O.A.; Supervision: O.A.; Data collection and/or processing: M.S.D., S.B.; Analysis and/or interpretation: M.S.D., S.B.; Literature search: B.A., O.A., M.K.; Writing: O.A., A.K.; Critical review: M.K., O.K.

**Conflict of Interest:** None declared.

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## REFERENCES

1. Spellar K, Lotfollahzadeh S, Gupta N. Diaphragmatic hernia. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2023.
2. Pancholi CK, Hombalkar NN, Dalvi SB, Gurav PD. Left sided hydro-pneumothorax in a operated case of left diaphragmatic hernia repair: A diagnostic dilemma. *J Clin Diagn Res* 2015;9:D03-4. [CrossRef]
3. Katukuri GR, Madireddi J, Agarwal S, Kareem H, Devasia T. Delayed diagnosis of left-sided diaphragmatic hernia in an elderly adult with no history of trauma. *J Clin Diagn Res* 2016;10:D04-5. [CrossRef]
4. Testini M, Girardi A, Isernia RM, De Palma A, Catalano G, Pezzolla A, et al. Emergency surgery due to diaphragmatic hernia: Case series and review. *World J Emerg Surg* 2017;12:23. [CrossRef]
5. Torfs CP, Curry CJ, Bateson TF, Honoré LH. A population-based study of congenital diaphragmatic hernia. *Teratology* 1992;46:555-65. [CrossRef]
6. Lu J, Wang B, Che X, Li X, Qiu G, He S, et al. Delayed traumatic diaphragmatic hernia: A case-series report and literature review. *Medicine (Baltimore)* 2016;95:e4362. [CrossRef]
7. Sano A, Kato H, Hamatani H, Sakai M, Tanaka N, Inose T, et al. Diaphragmatic hernia with ischemic bowel obstruction in pregnancy: Report of a case. *Surg Today* 2008;38:836-40. [CrossRef]
8. Moussa G, Thomson PM, Bohra A. Volvulus of the liver with intrathoracic herniation. *Ann R Coll Surg Engl* 2014;96:27-29. [CrossRef]
9. Barakat MJ, Vickers JH. Necrotic gangrenous intrathoracic appendix in a marfanoid adult patient: A case report. *BMC Surg* 2005;5:4. [CrossRef]
10. Liu S, Dai M, Ye B, Zhao Z, Shi Y, Peng L. Diaphragmatic hernia as a rare complication of colonoscopy: Case report and literature review. *Medicine (Baltimore)* 2018;97:e9660. [CrossRef]
11. Haratake N, Yamazaki K, Shikada Y. Diaphragmatic hernia caused by heterotopic endometriosis in Chilaiiditi syndrome: Report of a case. *Surg Today* 2015;45:1194-6. [CrossRef]
12. Brown SR, Horton JD, Trivette E, Hoffman LJ, Johnson JM. Bochdalek hernia in the adult: Demographics, presentation, and surgical management. *Hernia* 2011;15:23-30. [CrossRef]
13. Kaur R, Prabhakar A, Kochhar S, Dalal U. Blunt traumatic diaphragmatic hernia: Pictorial review of CT signs. *Indian J Radiol Imaging* 2015;25:226-32. [CrossRef]
14. Magu S, Agarwal S, Singla S. Computed tomography in the evaluation of diaphragmatic hernia following blunt trauma. *Indian J Surg* 2012;74:288-93. [CrossRef]
15. Fraga EC, Camacho CP, Almeida AC, Amaral MJ, Almeida JR. Iatrogenic diaphragmatic hernia after laparoscopic gastric band removal: A rare case report. *Int Surg J* 2020;7:557-9. [CrossRef]
16. Suh Y, Lee JH, Jeon H, Kim D, Kim W. Late onset iatrogenic diaphragmatic hernia after laparoscopy-assisted total gastrectomy for gastric cancer. *J Gastric Cancer* 2012;12:49-52. [CrossRef]
17. de Meijer VE, Vles WJ, Kats E, den Hoed PT. Iatrogenic diaphragmatic hernia complicating nephrectomy: Top-down or bottom-up? *Hernia* 2008;12:655-8. [CrossRef]
18. Vertaldi S, Manigrasso M, D'Angelo S, Servillo G, De Palma GD, Milone M. Robotic repair of iatrogenic left diaphragmatic hernia. A case report. *Int J Surg Case Rep* 2020;76:488-91. [CrossRef]
19. Lewis JD, Starnes SL, Pandalai PK, Huffman LC, Bulcao CF, Pritts TA, et al. Traumatic diaphragmatic injury: Experience from a level I trauma centre. *Surgery* 2009;146:578-83. [CrossRef]
20. Saroj SK, Kumar S, Afaque Y, Bhartia AK, Bhartia VK. Laparoscopic repair of congenital diaphragmatic hernia in adults. *Minim Invasive Surg* 2016;2016:9032380. [CrossRef]
21. Chen B, Finnerty BM, Schamberg NJ, Watkins AC, DePizzo J, Zarnegar R. Transabdominal robotic repair of a congenital right diaphragmatic hernia containing an intrathoracic kidney: A case report. *J Robot Surg* 2015;9:357-60. [CrossRef]
22. Sideris AC, Molena D. Robotic transthoracic diaphragmatic hernia repair. *JTCVS Tech* 2021;10:578-80. [CrossRef]
23. Antoniou SA, Pointner R, Granderath FA, Köckerling F. The use of biological meshes in diaphragmatic defects an evidence-based review of the literature. *Front Surg* 2015;2:56. [CrossRef]
24. Abboud NM, Rimbault M, Abboud S, El Nakadi I, Charara FG. A Surgical alternative in the treatment of recurrent diaphragmatic hernia after total gastrectomy. *Plast Reconstr Surg Glob Open* 2020;8:e3302. [CrossRef]

## ORIJİNAL ÇALIŞMA - ÖZ

### Diyafragma fitıklarının onarımı: 70 olgunun retrospektif analizi

**Dr. Osman Köneş, Dr. Ozan Akıncı, Dr. Sezer Bulut, Dr. Burak Atar, Dr. Mahmut Said Değerli, Dr. Mehmet Karabulut**

Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi, Genel Cerrahi Kliniği, İstanbul, Türkiye

**AMAÇ:** Konjenital ve travmatik diyafragma fitıkları (DF) ciddi morbidite ve mortalite nedeni olabilen solunumsal ve gastrointestinal komplikasyonlara yol açabilmektedir. Bu çalışmada, komplike veya komplike olmayan diyafragma fitıklarının cerrahi onarımına dair deneyimimizi paylaşmayı amaçladık.

**GEREÇ VE YÖNTEM:** 2009-2023 arasında DF nedeniyle acil veya elektif şartlarda ameliyat edilen hastalar geriye dönük olarak analiz edildi. Demografik özellikleri, öyküleri, semptomları, fitık etyolojileri, bilgisayarlı tomografi bulguları, ameliyat teknikleri ve postoperatif sonuçları kaydedildi.

**BULGULAR:** Olguların ortalama yaşı 51.5±18.5 olup 29'u kadın 41'i erkekti. Fitık etyolojisi sırasıyla, konjenital (%40), travmatik (%32.8), spontan (%14.3) ve iyatrojenik (%12.8) idi. Ortalama fitık defekti 7.3±2.76 cm (3-15 cm) olup fitıkların %84'ü sol tarafta idi. Olguların %60'ı laparoskopik, %11.4'ü laparotomi ile opere edildi. Laparoskopiden açığa geçiş oranı %24.3 idi. Hastaların %48'inde dual yama kullanıldı ve %34'ünde primer sütürasyon uygulandı. Postoperatif mortalite oranı %7.1 idi.

**SONUÇ:** Diyafragma fitıkları abdominal organ strangülasyonu, pulmoner ve kardiyak komplikasyonlar nedeniyle önemli bir morbidite ve mortalite nedenidir. Diyafragma fitığı tanısı konulduğunda laparoskopik veya açık cerrahi tercih edilmesi gereken tedavi yöntemidir.

**Anahtar sözcükler:** Acil cerrahi; diyafragma yırtılması; konjenital diyafragma fitığı; yama.

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