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Evaluation of diaphragmatic omental hernias by radiology: A prevalence study

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Abstract

INTRODUCTION: This study aimed to describe the radiological features of omental hernias originating from the diaphragm and their localization on the diaphragm, examine their relationship with the thoracic and abdominal organs, and present guiding data to clinicians in operational planning.

MATERIALS AND METHODS: This study was obtained as a result of retrospective scanning of the images of 824 patients aged 18–65 who applied for thorax and/or upper abdomen computerized tomography (CT). The patients' thorax and upper abdomen regions were examined in detail and divided into two groups of individuals with and without hernias. Hernia types, content, localization, and effect types of patients with hernia were recorded and analyzed separately.

RESULTS: Diaphragmatic hernia was detected in 197 (23.9%) of 824 patients. While 50.8% of these patients were female, 49.2% were male. Of the patients diagnosed with diaphragmatic hernia, 49.2% (n = 97) had Morgagni hernia, 30.5% (n = 60) had Bochdalek hernia, and 17.8% had hiatal hernia. While Morgagni hernia had anterior localization in 82.5%, Bochdalek hernia was generally localized on the left side (75.8%), and hiatal hernias were sliding type with a rate of 84.2%. The highest effect was observed in Bochdalek hernias (71.1%). Omental tissue (59.4%) was observed most frequently in Morgagni hernias, while stomach content (91.9%) was found to be the highest in hiatal hernias ($P < 0.05$).

DISCUSSION–CONCLUSION: Diaphragmatic omental hernias are rare. The rarity, as well as the uncertain and nonspecific presentations, contributes to the retard in diagnosis. Commonly, the presentation in the adult age group is that of recurrent chest infection and rarely with gastroesophageal reflux and esophagitis. Physicians caring for these patients should be aware of this, and a high index of suspicion is recommended to obviate delay in diagnosis with its associated morbidity. We think the radiological features of diaphragmatic hernias should be detailed in determining and applying the optimal treatment approach. In addition, contrary to what was thought, we found that the prevalence of diaphragmatic hernia in our population is higher than that reported in the literature.

Keywords:

Bochdalek, diaphragmatic hernia, morgagni, prevalence

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Introduction

A diaphragmatic omental hernia is a clinical condition that occurs when organs or structures in the abdominal cavity are displaced towards the thoracic cavity through congenital or subsequent defects in the diaphragm. Congenital diaphragmatic hernias occur in 1 out of every 2,000–3,000 live births, constituting 8% of all major congenital anomalies.[1] Also, a post-traumatic diaphragmatic hernia is not an uncommon sequel. However, a lack of awareness of this condition may delay diagnosis and result in life-threatening complications.[2] In both congenital and traumatic diaphragmatic hernias, computerized tomography (CT), chest X-ray, and ultrasonography of the chest and abdomen may also help reach the diagnosis. An awareness of the condition, assisted by the radiological investigations, will lead to

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an early diagnosis and treatment, which ultimately helps better manage patients with all diaphragmatic hernias.[3,4] In the literature, diaphragmatic hernias in adults have been little studied. Generally, studies are in the form of case reports. This study was conducted to evaluate the prevalence and subtypes of diaphragmatic hernias in adults by CT.

There are three basic diaphragmatic omental hernias: Bochdalek, Morgagni, and paraesophageal hiatal hernia. The most common localization of congenital hernias due to failure of the posterolateral diaphragm to fuse properly is the posterolateral (left postero-lateral 95%) foramen of Bochdalek. Morgagni hernia is observed at a rate of 1%–4% in the anterior-retrosternal distance, while esophageal hiatus hernias are observed at a rate of 1%.[2] 90% of diaphragmatic hernias in adult patients are Bochdalek hernias, which are more common on the left side, probably due to the protective effect of the liver on the right side.[3] In Bochdalek hernias, intraperitoneal fat, kidneys, or parts of the intestine pass through the spaces between the costal and vertebral parts of the diaphragm and arise posterolaterally. In left-sided hernias, it is seen as herniation of both the small and large intestines and intra-abdominal organs into the chest cavity, while in right-sided hernias (13%), the liver and a part of the large intestine tend to herniate.[4,5] Morgagni hernia occurs due to the displacement of intra-abdominal organs into the thoracic cavity through the defect between the septum transversum and the costal edges of the diaphragm, defined as the Morgagni foramen localized in the retrosternal area. Most hernias occur on the right side of the body and are usually asymptomatic, but newborns may experience respiratory distress similar to that seen in Bochdalek hernias.[6,7] Paraesophageal hernias, which have a very low prevalence, mostly mimic a mediastinal lipomatous tumor. When a mass with fat density in the posterior mediastinum is seen on CT imaging, possible diagnoses are lipomatous tumors (lipoma or liposarcoma) or esophageal hernia.[8,9] CT alone can now be an excellent diagnostic method for paraesophageal hernias, as recent technical advances in CT can provide high-resolution and multiplanar reconstruction images.[10-12]

Patients are usually asymptomatic when hernia sacs contain only omental fat. Therefore, it has been determined that studies on omental diaphragmatic hernias are presented case-by-case in the literature. In this study, we aim to raise clinicians' awareness about diaphragmatic hernias before planning a surgical intervention and provide radiological guidance for accurate and precise diagnosis of related hernias on tomography images. This study was conducted to investigate the prevalence of omental diaphragmatic hernias in adults, to support the treatment and surgical approaches of related imaging findings.

Materials and Methods

Study design

This study was planned as a retrospective study. All procedures in this study were performed in accordance with the ethical standards of the institutional and/or national research committee, in addition to the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This study was approved by a local non-interventional research ethics committee (Ankara Medipol University, Date: 5 July 2022, Decision No. 128). Informed consent was obtained from all participants included in the study.

Data collection

A total of 1,022 thorax and abdomen examinations obtained with various prediagnoses in the Radiology Department between January 2017 and June 2022 were retrospectively scanned. Considering 80% power and 8% omental diaphragmatic hernia frequency, 824 samples were studied. The sample size was calculated with G*Power 3.1.2 program. In this study, images of 1,022 patients aged 18–65 years who underwent thorax and/or upper abdomen CT examination in our center between January 2017 and June 2022 were evaluated, and patients under 18 years of age with a history of trauma and/or operation related to the thorax and diaphragm were excluded from the study. The images of the remaining 824 patients were scanned retrospectively from the PACS system, and the relevant results were analyzed.

Two expert radiologists examined the images, and the patient's information and findings were recorded. All findings were determined by the joint decision of two radiologists. Presence and diaphragmatic hernias (Bochdalek, Morgagni, and hiatal hernias), localization, content, relationship with neighboring structures and type of effect, and age and gender of the patients were recorded. Effects were classified as ground-glass density in the lung parenchyma due to compression, atelectasis, collection, repulsion, and stenosis of luminal organs.

Image acquisition

CT examinations were performed in the supine position with a multislice computed tomography device (MSCT) (General Electric IQ™ 32-Detector Spiral MSCT). The acquisition parameters are 200–320 mAS, 120 kV, an average 350 mm field of view (FOV), and 1.25 mm slice thickness. Images were evaluated axially, coronally, and sagittally in the bone and soft tissue windows. RadiAnt DICOM Viewer 2021.2.2 program was used for evaluation processes.

Statistical analysis

The data obtained in the research were analyzed using the SPSS (Statistical Package for Social Sciences) for

Windows 22.0 program. Number, percentage, mean, and standard deviation were used as descriptive statistical methods to evaluate the data. The relationship between categorical variables was analyzed with a chi-square test. The significance level was accepted as $P < 0.05$.

Table 1: Descriptive information of all patients in the study

		N	%	
Group	Hernia	197	197	23.9
	No hernia	627	76.1	
	Total	824	100.0	
Gender	Female	386	386	46.8
	Male	438	53.2	
	Total	824	100.0	

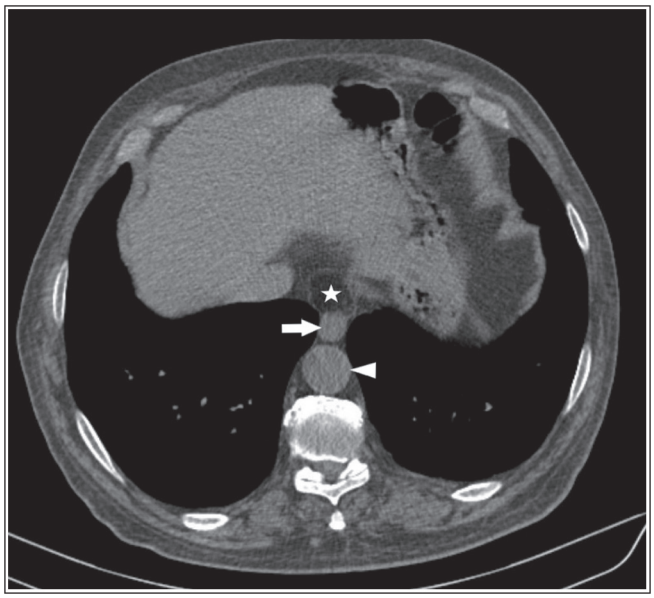

Figure 1: Transverse computerized tomography (CT) image (mediastinal window). Thorax hernia paraesophageal omental fat (star), distal esophagus (white arrow), aorta (arrowhead)

Results

The diaphragmatic hernia was detected in 197 of 824 patients in the study. While 46.8% of the total patients were female, 53.2% were male [Table 1].

Of 197 patients with diaphragmatic hernia, 11.8% ($n = 97$) had Morgagni hernia, 7.3% ($n = 60$) had Bochdalek hernia, and 4.2% ($n = 35$) had hiatal hernia [Figures 1–4]. In 0.6% of the patients ($n = 5$), two hernias were found together. Bochdalek–Morgagni hernia was found together in 2 of these 5 patients, and Hiatal–Morgagni hernia in 3 patients [Table 2].

It was determined that in 65.5% of patients with a diaphragmatic hernia, hernias did not cause any effect on the lung parenchyma. However, ground glass was found in 22.8% ($n = 45$), atelectasis in 3% ($n = 6$), and ground glass+atelectasis in 8.6% ($n = 17$).

In the evaluation of the total content of hernias, the maximum amount of hernia content was determined to have the omental adipose tissue at a rate of 78.7% ($n = 155$), the stomach at a rate of 18.8% ($n = 37$), and the liver at a rate of 2% ($n = 5$) [Table 3].

It was determined that 82.5% of Morgagni hernias were located in the anterior, 12.4% in the right hemithorax and anterior, and 4.1% in the right hemithorax. On the other hand, 4.8% of Bochdalek hernias were bilateral, 16.1% on the right, and 75.8% on the left. In the classification of hiatal hernia types, it was observed that it was a sliding type with a maximum rate of 84.2%. Figure 5 presents the distribution of diaphragmatic hernias according to their localization.

Table 4 shows the relations of Morgagni, Bochdalek, and hiatal hernias with gender, effect type, and content. According to the table, there is no statistical significance between gender and hernia types. In the effect type evaluation, no effect was observed in 67.4% of Morgagni

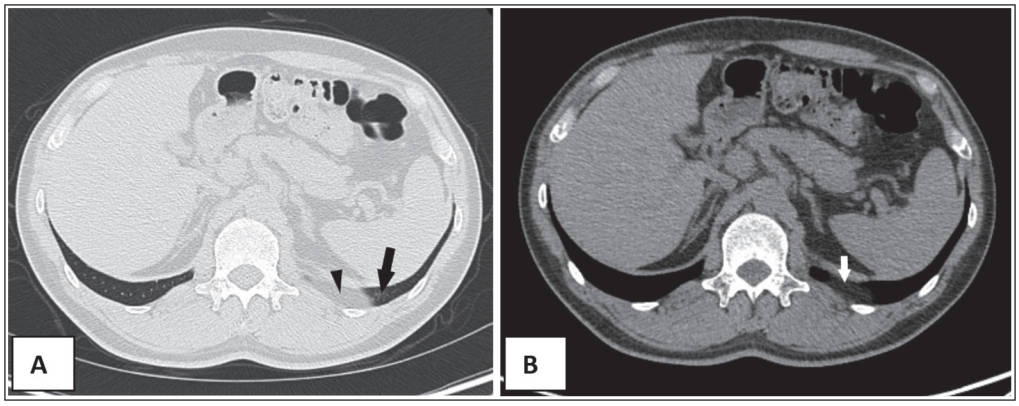

Figure 2: (same patient) A: transverse computerized tomography (CT) image (parenchyma window). Thorax hernia omental fat (Bochdalek hernia: black arrowhead), ground glass (black arrow) due to compression in the pulmonary parenchyma. B: Transverse CT image (mediastinal window). Thorax hernia omental fat (Bochdalek hernia: black arrow)

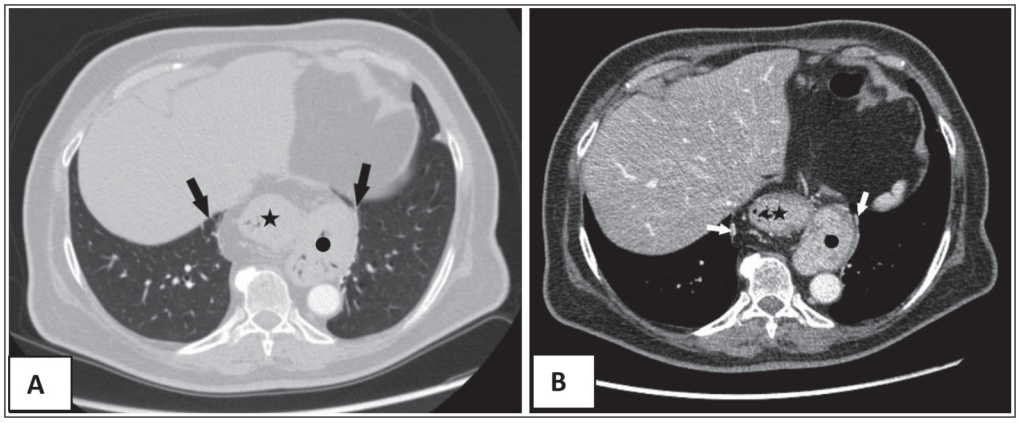

Figure 3: (same patient) A: Transverse computerized tomography (CT) image (parenchyma window). Mixed hiatal hernia. (star: sliding hernia, circle: rolling hernia), atelectatic band appearances due to compression in the pulmonary parenchyma (black arrows). B: Transverse CT image (mediastinal window). Compression-related atelectasis appearances in the pulmonary parenchyma (white arrows)

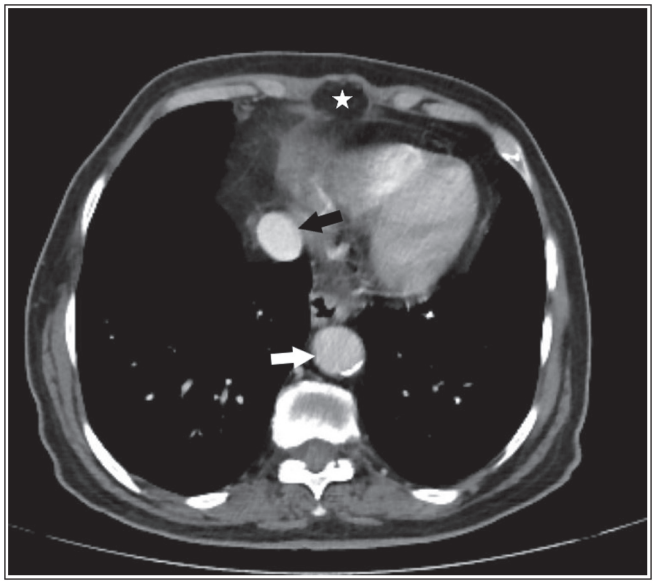

Figure 4: Transverse computerized tomography (CT) image (mediastinal window). Thorax hernia omental fat (Morgagni hernia: white star), inferior vena cava (black arrow), thoracic aorta (white arrow)

Table 2: Frequency of hernia

		N	%
Type of hernia	No hernia	627	76.1
	Morgagni	97	11.8
	Bochdalek	60	7.3
	Hiatal	35	4.2
	B&M/H&M	5	0.6

B = Bochdalek, M = Morgagni, H = Hiatus

hernias, while no effect was observed in 12.4% of Bochdalek hernias and 17.1% of hiatal hernias.

While it was determined that 71.1% of Bochdalek hernias showed the effect of ground glass, ground glass was observed in 20% of hiatal hernias. It was determined that atelectasis was mainly observed in Bochdalek hernia, and

Table 3: Characteristics of diaphragmatic hernias

		N	%
Effect type	No effect	129	65.5
	GG	45	22.8
	AT	6	3.0
	GG+AT	17	8.6
	Total	197	100.0
Content	omental	155	78.7
	stomach	37	18.8
	colon	1	0.5
	liver	4	2.0
	Total	197	100.0

GG = Ground-glass, AT = Atelectasis, GG+AT = Ground-glass + Atelectasis

their differences were statistically significant ($P < 0.05$). It was determined that the effect of ground glass and atelectasis together did not create statistical significance between hernia types ($P > 0.05$).

In the evaluation of hernia content, it was observed that 59.4% of Morgagni hernias and 38.7% of Bochdalek hernias had omental content. It was determined that gastric content was observed in 91.9% of hiatal hernias, and that of the liver was seen only in Morgagni hernia. Two hernias were observed in 0.6% ($n = 5$) of the patients [Table 4].

Discussion

This rare study provides critical evaluations to reveal the radiological and anatomical features of diaphragmatic hernias in adults and determine their prevalence in society. Numerous studies have been conducted on congenital diaphragmatic hernias in the literature, and they have been little studied because they are generally asymptomatic in adults. In our retrospective review of 824 patients who had thorax and upper abdomen CT, 197 (23%) patients had diaphragmatic hernias, and 11.8% of

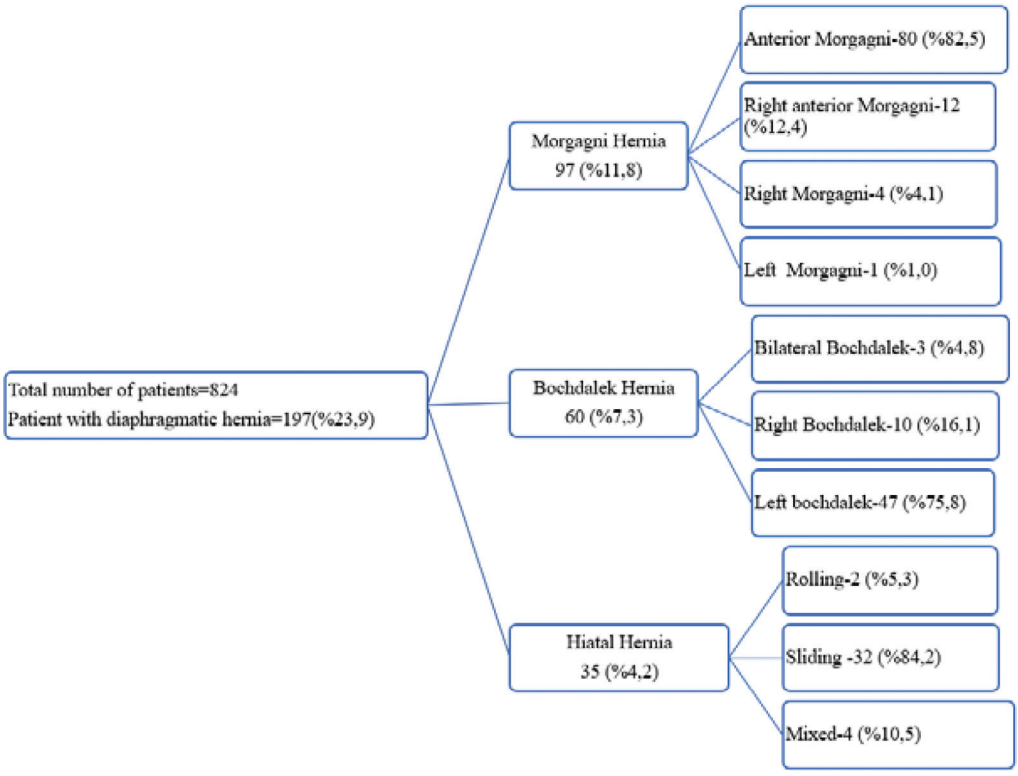

Figure 5: Classification and prevalence of diaphragmatic hernias according to their localization (frequency/percent)

Table 4: The relationship between diaphragmatic hernias and gender, effect type, and content

		Morgagni	Bochdalek	Hiatal	B&M/ H&M	*P*-Value
Gender						
Female	*N*	55_a	28_a	15_a	2_a	0.411
	%	55.0	28.0	15.0	2.0	
Male	*N*	42_a	32_a	20_a	3_a	
	%	43.3	33.0	20.6	3.1	
Effect type						
No effect	*N*	87_a	16_b	22_c	$4_{a,b,c}$	0.00*
	%	67.4	12.4	17.1	3.1	
GG	*N*	4_a	32_b	9_b	$0_{a,b}$	
	%	8.9	71.1	20.0	0.0	
AT	*N*	0_a	5_b	$1_{a,b}$	$0_{a,b}$	
	%	0.0	83.3	16.7	0.0	
GG+AT	*N*	6_a	7_a	3_a	1_a	
	%	35.3	41.2	17.6	5.9	
Content						
Omental	*N*	92_a	60_a	1_b	2_c	0.00*
	%	59.4	38.7	0.6	1.3	
Stomach	*N*	0_a	0_a	34_b	3_c	
	%	0.0	0.0	91.9	8.1	
Colon	*N*	1_a	0_a	0_a	0_a	
	%	100.0	0.0	0.0	0.0	
Liver	*N*	4_a	0_a	0_a	0_a	
	%	100.0	0.0	0.0	0.0	

[a,b,c]There is significance between different alphabets (in subscript)
*Significance at $P < 0.05$
Test: Chi-square, $P < 0.05$, GG = Ground-glass, AT = Atelectasis, GG+AT = Ground-glass + Atelectasis

these patients had Morgagni, 7.3% Bochdalek, and 4.2% hiatal hernia. Also, in this study, 84.2% of hiatal hernias were sliding, 5.3% rolling, and 10.7% mixed type.

Diaphragmatic hernias are usually small and contain the most common omentum and transverse colon, while the stomach, liver, cecum, terminal ileum, and ascending colon rarely herniate.[13-19] In a study, it was reported that every non-retroperitoneal abdominal organ could be found in these hernias, but only the omentum (31%) or the colon and omentum (29%) were most frequently found in the hernia sac. In the same study, it was stated that the stomach (15%), small intestine (11%), and liver (4%) could be found in the hernia sac.[7] Some studies argue that hiatal hernia is more likely to have more severe symptoms than colon and/or omental hernias.[20,21] In our study, the presence of omental adipose tissue was determined at the rate of 78.7% ($n = 155$), stomach at the rate of 18.8% ($n = 37$), and liver at the rate of 2% ($n = 5$) in the hernia content. Katsaros *et al.*[16] reported that the contents of the hernia were formed by the omental adipose tissue (74.5%) and the transverse colon (65.1%), followed by the stomach, liver, and small intestines, respectively.

Morgagni and Bochdalek hernias have generally been investigated in the literature, and there are few studies on hiatal hernias. Horton *et al.*[7], reviewing 135 articles reporting clinical data for 298 patients, reported that 106

of these 135 articles were single-patient case reports, and the rest were imaging and surgical technique research. Also, investigating the prevalence of Morgagni hernias, Comer and Clagett[14] conducted their study with 1,750 patients and investigated the radiological and surgical features of only Morgagni patients. The literature states that Morgagni hernia is a rare congenital diaphragmatic hernia that accounts for 3%–5% of all cases.[22,23] Chavlan *et al*.[24] reported that 12% of diaphragmatic defects identified in infancy are Morgagni hernias. Similarly, Berman *et al.* (1989) reported 15 cases of Morgagni over a 20-year period. Our study determined that 11.8% ($n = 97$) of 197 adult patients diagnosed with diaphragmatic hernia had Morgagni hernia.[25] Our study is one of the specific studies on Morgagni hernia in adults. This study determined that 82.5% of Morgagni hernias (11.8%) were anterior, 12.4% were right anterior localized, and 4.1% were only in the right hemithorax. In many studies on the localization of Morgagni hernias, it has been reported that approximately 90% of them are on the right side, 8% are on the left, and 2% are bilateral.[26-28] It is thought that Morgagni hernias are more common on the right side due to the support provided by the pericardial attachments on the left.[29] It is known that bilateral Morgagni hernias are very rare. In our study, the presence of bilateral Morgagni was not detected. Generally, it is reported that bilateral Morgagni hernia may be associated with heart enlargement due to autism spectrum disorder (ASD) in children.[21] In adulthood, the follow-up of these patients is critical due to the possible neighborhood of Morgagni hernia with the heart in the relevant patient group.

There are approximately 150–200 reports of adult Bochdalek hernia in the world literature. Bochdalek hernia is usually congenital and may result from irregular development of the diaphragm but may also occur due to surgery, trauma, or infection. Most of the defects created by hernia are incidental, asymptomatic posterolateral diaphragmatic defects.[30,31] Mullins *et al*.[32] conducted the most comprehensive study on Bochdalek hernias. These researchers retrospectively reviewed reports of 13,138 abdominal CT scans and found that this finding was reported in 22 patients, representing a prevalence of 0.17%. Symptomatic Bochdalek hernias in adults are relatively rare but can lead to incarcerated bowel loops, intra-abdominal organ dysfunction, or severe lung disease.[32,33] It has been reported that the prevalence of Bochdalek hernias varies between 3%–6%.[3] Our study found that Bochdalek hernia was seen in 7.3% of the patients ($n = 60$). It is seen that our results are compatible with the literature.

Most Bochdalek hernias (80%–85%) occur on the left side of the diaphragm. Most of the remaining cases are on the right side, and a small portion is bilateral[12]. Our study found that 4.8% of Bochdalek hernias were bilateral, 16.1% on the right, and 75.8% on the left. Sandstrom *et al*.[14] stated that 90% of Bochdalek hernias in adult patients are more frequently on the left side, probably due to the protective effect of the liver on the right side, and they are rarely bilateral. Wiseman[34] reported that approximately 85% of Bochdalek hernias are seen on the left, and herniation of small and large intestines and intra-abdominal solid organs into the chest cavity can be seen. The same study also emphasized that in right-sided hernias (13% of cases), only the liver and part of the large intestine tended to herniate. Our results are consistent with the literature, and it was determined that Bochdalek hernias are more common on the left and the content is primarily omental adipose tissue.

In our study group, the presence of a hiatal hernia was detected at a rate of 4.2%. In this type of hernia, which is usually associated with gastroesophageal reflux, hernia usually occurs when all or a part of the stomach passes into the chest. Gastroesophageal reflux and esophagitis are common, and in rare cases, lung fibrosis is possible after severe acid reflux. Paraesophageal hiatal hernias most commonly occur as a sliding (in 90% of cases) type with a displacement of the gastroesophageal junction and part (or all) of the stomach toward the chest cavity and loss of the usual antireflux mechanism. Less commonly, intrathoracic hiatal hernias develop as the rolling type, in which part (or all) of the stomach or other abdominal contents, such as the spleen or intestines roll over the gastroesophageal junction to enter the thoracic cavity.[35] It can also occur with rolling and sliding types.[35-37] In our study, 84.2% of hiatal hernias were sliding, 5.3% rolling, and 10.7% mixed.

The effects of diaphragmatic hernias on adjacent organs, especially lung parenchyma, have not been studied much before. In our study, we investigated these changes and observed that 25.8% of the patients with hernias had ground glass or atelectasis in the lung parenchyma due to the compression effect. Compression findings were atelectasis in 3% of patients, ground glass in 22.8%, and both in 8.6% of patients. While the most effective hernia type was Bochdalek hernia (ground glass: 71.1%; atelectasis 83.3%), this rate was 20.0% in ground glass and atelectasis 16.6% in hiatal hernias; in Morgagni hernia, the rate of ground glass was found to be 8.9%, and the rate of ground glass and atelectasis together was found to be 35.3%. Our study did not detect any sign of significant intestinal stenosis or ischemia. The hernia dimensions we did not evaluate in our study are likely to have a share in the formation of the compression effect.

The most important limitation of our study is the lack of clinical features of the patients. The most important

shortcoming of our study is that it is retrospective and single-centered.

Conclusion and Evaluation

Our research is a study conducted to define diaphragmatic hernias seen in a large sample in the community and yielded significant results. Multiple imaging modalities are available to evaluate diaphragmatic hernias. Radiographs often offer the first clue to the diagnosis. Upper gastrointestinal radiography can identify omental hernia and related complications. CT provides highly instructive results for further evaluation of these abnormalities, accurate determination of hernia type, content, and associated complications, and a roadmap for surgical planning.

As only a limited number of reviews have been presented on Bochdalek, Morgagni, and especially hiatal hernias, our study provides clinicians with guiding results to evaluate their patients better.

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Conflicts of interest
There are no conflicts of interest.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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