

Prevalence and MDCT characteristics of asymptomatic Bochdalek hernia in adult population

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PURPOSE

To determine the frequency of asymptomatic incidental Bochdalek hernias in adults, using multidetector computed tomography (MDCT), and to ascertain any possible relationship between Bochdalek hernia and age, gender, or body mass index (BMI).

MATERIALS AND METHODS

Seven hundred and forty-eight abdominal, and 602 chest MDCT scans, which had been performed for a variety of reasons on 1350 adults, were investigated retrospectively. Location and size of Bochdalek hernias seen on these scans were correlated with age, gender, and BMI. On the basis of BMI, patients with Bochdalek hernia were classified as group A (BMI <25) and group B (BMI ≥25).

RESULTS

A total of 171 Bochdalek hernias were identified in 142 of 1350 patients, ranging in age from 25 to 90 years (median age, 57.2), representing a prevalence of 10.5%. Sixty left-sided unilateral Bochdalek hernias (42.2%), 53 (37.4%) right-sided unilateral Bochdalek hernias, and 29 (20.4%) bilateral Bochdalek hernias were detected. Forty-five (31.6%) were categorized as small, 82 (57.8%) were medium-sized, and 15 (10.5%) were large. BMI was <25 in 62 patients (43.7%), and ≥25 in 80 patients (56.3%). Fourteen patients (9.9%) were young adults, while 86 (60.6%) were middle aged, and 42 (29.6%) were elderly. No statistically significant relationship was found between dimensions or hernia locations and age, gender, or BMI of patients with Bochdalek hernia.

CONCLUSION

In view of the high prevalence of Bochdalek hernia in our study (10.5%), the multiplanar and reconstruction features of MDCT seem to facilitate the diagnosis of asymptomatic incidental Bochdalek hernia. No relationship was found between asymptomatic incidental Bochdalek hernia and age, gender, or BMI in adults.

Key words: • diaphragmatic hernia • prevalence • computed tomography

The diaphragm, which forms an anatomical wall between the thoracic and abdominal cavities, develops in the first to fourth months of gestation, along with the body wall muscles, septum transversum, pleuroperitoneal membranes, and mediastinal dorsal mesentery of the esophagus (1, 2).

Congenital disorders of the diaphragm result in fusion defects of the diaphragm or maldevelopment of the gut accompanied by closure of the diaphragm. Congenital diaphragmatic hernias are categorized as Bochdalek (posterolateral), Morgagni (anterior-retrosternal), and hiatal hernias and septum transversum defect. Worldwide, congenital diaphragmatic hernias occur in one out of every 2,000–12,500 live births (3).

First described in 1867 by Victor Alexander Bochdalek (4), Bochdalek hernia is the most common type of diaphragmatic hernia, accounting for 95% of cases. Most cases are symptomatic at birth, and are diagnosed in the neonatal period.

In adults, most Bochdalek hernias are asymptomatic, and therefore their detection is usually incidental. The real prevalence in the population is unknown, with an estimated range between 0.17% and 12.7% (5–8). The widespread use of multi-detector row computed tomography (MDCT) for the evaluation of thoracic and abdominal disease, with its inherent rapid scan acquisition and thin collimation technique, has resulted in a significant increase in the incidental discovery of occult lesions. Thus, the aim of this study was to determine the prevalence of asymptomatic incidental Bochdalek hernias detected by MDCT, and to investigate a possible relationship between Bochdalek hernia and body habitus.

Materials and methods

Study population

Our institutional board on medical ethics approved this research study. Informed consent was not required for this retrospective analysis. Patient confidentiality was protected. We reviewed computer records of all patients who underwent MDCT of the chest and/or abdomen at our institution between February 1, 2007 and November 30, 2007. After excluding any patients with blunt or penetrating body trauma, and abdominal, thoracic, or diaphragm operations, 1,350 consecutive patients over the age of 18 years were included in the study. MDCT examinations were performed for various indications, including follow-up of known abdominal and chest and/or abdomen disorders, primary or metastatic tumor investigations, vascular pathology, and evaluation of infectious diseases. No MDCT scan had been obtained specifically to evaluate diaphragmatic disease.

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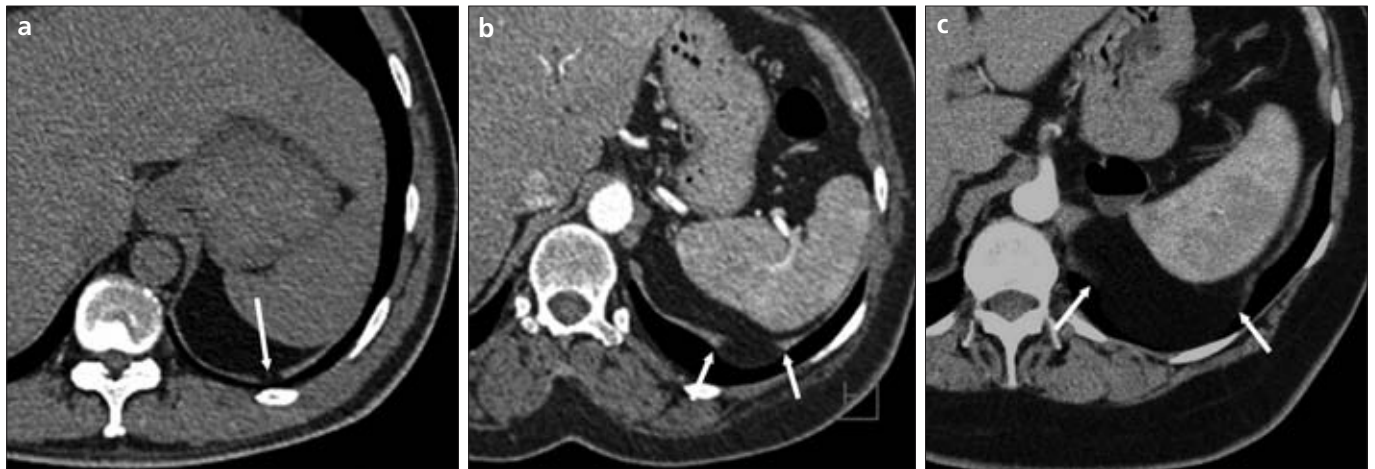


Figure 1. a–c. Transverse CT images with soft tissue windows demonstrating (a) a small (arrow), (b) medium (arrows) (c) and large (arrows) fat-containing Bochdalek hernia.

MDCT protocol

Seven hundred and forty-eight patients underwent abdominal computed tomography (CT) scans, and 602 underwent thoracic CT scans. The MDCT examinations were performed with 2- and 4-detector row CT scanners (Hispeed NXi Dual; GE Medical Systems, Milwaukee, Wisconsin, USA; Somatom Sensation 4 and Definition, Siemens Medical Systems, Forchheim, Germany). MDCT was performed during intravenous power injection of iodinated contrast material in 98.5% of patients at a rate of 1.5–2.0 mL/kg of body weight. Intravenous contrast material was not given to patients who had a contraindication to iodinated contrast agent or in whom urinary tract stones were evaluated. All patients received oral contrast material or water for abdominal scanning. All examinations were performed with the patient in the supine position holding an inspired breath. Scanning parameters with 2-detector row CT scanners were 80–120 kV (peak), 100–150 mAs, 0.5 s gantry rotation time, and 3–5 mm multiplanar reconstruction (MPR) image thickness. For 4-detector row CT, scanning parameters were 100–120 kV (peak), 150–200 mAs, 0.5–1 s gantry rotation time, and 1–3 mm MPR image thickness.

Image analysis

MDCT images were reviewed for the presence, location, and virtual size of Bochdalek hernias. Analysis of the MDCT data in all subjects was based on axial scans and multiplanar reconstructed images. All data were post-

processed using commercially available workstations (AW Volume Viewer 1.2, GE Medical Systems; and Leonardo, Siemens Medical Systems). When necessary, curved-planar images were also added to the multiplanar reconstruction images. The reconstructed images were evaluated simultaneously by three radiologists (O.T., H.G. and E.Y.) who reached a consensus. Bochdalek hernia location was determined as right, left, or bilateral. They were classified into three groups, according to the maximum dimension of the diaphragmatic defect: small (<2 cm), medium (between 2 and 5 cm), and large (>5 cm).

Patient analysis

A retrospective chart review was performed to obtain each patient's gender, age, weight, and height on the MDCT examination dates. To simplify the statistical evaluation, the patients with Bochdalek hernias were categorized into three age groups: young adults, between the ages of 18 and 39; middle aged, between the ages of 40 and 65; and elderly, over 65 years of age. Body mass index (BMI) was calculated (body weight/height² in kg/m²), and patients were classified as group A (underweight or normal weight, BMI <25) or group B (overweight or obese, BMI ≥25).

Statistical analysis

The comparison of continuous variables was performed by Mann-Whitney U-test, while for comparison of proportions, the χ^2 test with a Yates' correction (when appropriate) was used. Dif-

ferences were considered to be statistically significant when $P < 0.05$.

Results

A total of 171 Bochdalek hernias were identified in 142 adult patients, a prevalence of 10.5% (142/1350). Sixty patients (42.3%) had unilateral hernias on the left side, 53 (37.3%) on the right side, and 29 patients (20.4%) had bilateral hernias. Fifty-two Bochdalek hernias (30.4%) were classified as small, 98 (57.3%) medium-sized, and 21 (12.3%) large.

Of the 142 patients with Bochdalek hernias, there were 86 men (60.6%) and 56 women (39.4%), with an age range of 25 to 90 years, and a median age of 57.2 years. There were 14 young adults (9.9%), 86 middle-aged (60.6%), and 42 elderly patients (29.6%). Sixty-two patients (43.7%) were classified as group A (BMI <25), and 80 patients (56.3%) as group B. (BMI ≥25). No statistically significant relationship was found between the location of Bochdalek hernia and BMI ($P = 0.734$), age ($P = 0.665$), or gender ($P = 0.182$).

Omental fat was the only herniated structure within the Bochdalek hernia in the majority of patients ($n = 137$, 96.5%) (Fig. 1). In the remaining five patients (3.5%), the hernias contained the liver ($n = 1$) (Fig. 2a, b), stomach ($n = 1$), kidney ($n = 2$) (Fig. 2c, d), or the stomach, large bowel, and duodenum ($n = 1$) in addition to omental fat.

Discussion

Bochdalek hernia is a type of congenital diaphragmatic hernia that commonly presents in childhood. It



Figure 2. a–d. A 47-year-old woman (a, b) and a 53-year-old man (c, d). Transverse CT image with soft tissue windows demonstrates a mass-like lesion (asterisk) in left inferior intrathoracic area (a). Sagittal reformatted CT image shows the liver herniating via a diaphragmatic defect to the right hemithorax (b, asterisk). Transverse (c) and sagittal reformatted (d) CT images with soft tissue windows demonstrate a Bochdalek hernia (arrows) partially containing the left kidney.

is caused by incomplete closure of the normal pleuroperitoneal canal, which leads to a posterolateral defect in the diaphragm. The majority of reported cases of Bochdalek hernia present with cardiorespiratory symptoms in the neonatal period. Late-presenting cases may be complicated with gastric volvulus, splenic rupture, gastric or other intestinal obstruction, and/or perforations (8–11). These are all generally associated with a good prognosis (12, 13); however, most of the cases of Bochdalek hernia in adults are likely to be asymptomatic, and therefore, the detection of Bochdalek hernia is usually incidental. Generally-accepted causes for acquired Bochdalek hernias include physical exertion, trauma, pregnancy, labor, coughing, sneezing, and large meals (12).

Various imaging investigations may be used in diagnosis. Plain chest and abdominal radiography, fluoroscopy, barium studies, ultrasound, helical CT, MDCT, magnetic resonance imaging, laparoscopy, and laparotomy have been used recently in diagnosis

of Bochdalek hernia, but MDCT is the most-preferred noninvasive procedure among these (14–16).

In a conventional CT study, Gale reported a prevalence of 6% for Bochdalek hernia in 1985, while Mullins et al. reported a lower prevalence of 0.17% in 2001 (5, 8). Nevertheless, these studies are limited due to the use of conventional CT or a retrospective chart review, leading to discordant results. Recently, by using MDCT, Kinoshita et al. (6) found a higher prevalence (12.7%), than did the previous studies. This figure is similar to the prevalence obtained in our study (10.5%). Because the frequency of Bochdalek hernia varies within different populations, the real prevalence in the adult population is unknown. The fact that Kinoshita et al. reevaluated the CT images specifically for Bochdalek hernias instead of relying on written reports, and used MDCT with MPR images in diagnosis, may be the principle reason for this high prevalence; however, the most important factor for increased detection of Boch-

dalek hernia is the wide use of MDCT in routine practice.

The prevalence of left- and right-sided Bochdalek hernias is a controversial topic. Left-sided predominance has been reported, to have a prevalence between 70% and 90% in most reports (6, 8, 14, 17). It is believed that the relatively early formation of the right hemidiaphragm, followed by the left, is related to the presence of the liver, which normally barricades herniation on the right side, leading to left-sided predominance of diaphragmatic hernias; however, Mullins et al. (5) reported percentages of Bochdalek hernias as 68% on the right side, 18% on the left side, and 14% bilateral. In our study, Bochdalek hernias were observed as 42.2% left-sided, 37.4% right-sided, and 20.4% bilateral, with no statistically significant correlation of location and prevalence ($P > 0.05$). The size distribution of Bochdalek hernias was similar on either side, and no statistically significant difference between size and left and right predominance was demonstrated in the present study.

Obesity could be considered to be contributory to Bochdalek hernias. There may be an imbalance between increased intra-abdominal pressure and Bochdalek hernias, as in hiatal hernias (18), and elevated BMI may be associated with increased intra-abdominal pressure (19); however, there is no scientific evidence concerning a relationship between BMI and an increased risk for Bochdalek hernias of the diaphragm. No correlation was found with asymptomatic incidental Bochdalek hernias and BMI in our study, in accordance with the current literature.

Mullins et al. (5) and Tibboel and Gaag (20) reported a female predominance for Bochdalek hernias; however, we observed a male predominance in Bochdalek hernia prevalence in our series, similar to the data reported by Kinoshita et al. (6). Most of the Bochdalek hernias were left-sided in men; in women, right-sided hernias were more common. The prevalence of bilateral Bochdalek hernias was lower in women.

It is well known that muscle power diminishes with age, because aging predisposes to weakness of connective tissue. For this reason, we searched for a correlation between aging and prevalence of asymptomatic Bochdalek hernias in adults, but found no such relationship.

In conclusion, incidental Bochdalek hernias are being detected with increasing frequency due to advances in imag-

ing modalities. The diaphragm can be thoroughly evaluated using axial and multiplanar reconstructed MDCT images, and diaphragmatic defects can be diagnosed much more easily and with greater certainty. Thus, the highest prevalence of Bochdalek hernias (10.5%) was observed with MDCT. No correlation was identified between asymptomatic incidental Bochdalek hernias and age, gender, or body habitus in adults.

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