



## Case Report

## Possibility of visualization of gastrothorax based on unenhanced postmortem computed tomography/PMCT

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## ABSTRACT

We present a fatal case of a gastrothorax due to an acute gastric volvulus resulting from a Bochdalek hernia. A 5-year-old boy without previous medical history was brought to our institution in a state of cardiopulmonary arrest and was subsequently pronounced dead. Postmortem computed tomography (PMCT) of the torso showed abdominal organs involving the lower section of the esophagus up to the entire stomach, the left side of the transverse colon, the entire spleen, and the tail of the pancreas herniated into the left thoracic cavity. The stomach was markedly expanded and a mesentero-axial (rotation along the short axis) volvulus was observed, displacing mediastinal structures to the right side and depressing the diaphragmatic contour. A PMCT of the thorax at the lung window setting revealed displacement of bilateral lungs. The bilateral lungs were severely atelectatic and congested. The PMCT findings mentioned above were consistent with the autopsy findings. PMCT can provide useful information for the diagnosis in cases we initially cannot predict any significant changes, for example, organ displacement.

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## 1. Introduction

Bochdalek hernia is a type of congenital diaphragmatic hernia (CDH) that was first described by Bochdalek in 1848 [1]. Bochdalek hernias present with abnormal pathological features, mainly on the diaphragm and the lung [2,3]. The diaphragmatic lesion is a posterolateral defect that is mainly found on the left side (74–84%), where the abdominal organs herniate into the thoracic cavity. A posterolateral defect is considered to be caused by the failure of the pleuroperitoneal canal to close at eight weeks' gestation [4]. The lung lesion is characterized by hypoplasia, which is hypothesized to be caused by genetic/environmental factors and interference with fetal breathing movements by herniated organs [3]. Bochdalek hernia is commonly diagnosed in neonatal or post-natal patients who present with acute respiratory symptoms. Patients may also present with chronic respiratory symptoms or gastrointestinal symptoms after an asymptomatic period, which is regarded as a late presenting Bochdalek hernia [5,6]. A rare case of a late presenting Bochdalek hernia is complicated by acute

gastric volvulus (AGV), which is characterized by an intrathoracic stomach twisted either organo-axially (rotation along the long axis) or mesentero-axially (rotation along the short axis) [7–9]. In these cases, the flow of materials is obstructed and intragastric air is trapped due to torsion, resulting in a massive expansion of the stomach in the thoracic cavity.

Tension gastrothorax is a life-threatening complication of CDH or traumatic diaphragmatic rupture that is caused by a one-way expansion of the stomach into the thoracic cavity [10–12]. Tension gastrothorax can compress the ipsilateral pulmonary parenchyma and the mediastinum to the opposite hemithorax causing respiratory distress and obstruction of venous return to the heart. Delayed diagnosis of tension gastrothorax results in cardiac arrest or, in the worst cases, sudden death. In this study, we present a possibility of visualization of gastrothorax based on unenhanced postmortem computed tomography/PMCT, correlating with findings on autopsy.

## 2. Case report

The subject was a 5-year-old boy without previous medical history. The subject was brought to our institution in a state of cardiopulmonary arrest. The parents testified that the subject

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had complained of abdominal pain the previous day and was seen in the pediatric clinic, where the pediatrician palpated the gas on the stomach. The pediatrician diagnosed a common cold and prescribed pain medications. During the night, the subject presented with breathing difficulties, vomiting, convulsion, and subsequent loss of consciousness. The subject was pronounced dead despite cardiopulmonary resuscitation attempts. A blood exam in the emergency department revealed an elevation of inflammatory markers (white blood cells, 14,500/ $\mu$ L; C-reactive protein, 2.14 mg/dl), indicating mild systemic inflammation or local inflammation in the body. A medico-legal investigation was initialized to ascertain the manner and cause of death.

A whole-body PMCT was performed 30 min postmortem. The PMCT was performed with a 64-channel multidetector row CT scanner (Lightspeed VCT; GE Healthcare, Milwaukee, USA) in the radiology department of our institution. The scan parameters for the helical scan mode for the thorax, abdomen, and pelvis were as follows: auto mA (standard deviation value: 20), 120 kV, 1.0 s/rotation, 0.625 mm collimation, pitch 1.375, and contiguous 1.25-mm sections. A board-certified radiologist observed and interpreted the images at appropriate window settings for each region. PMCT scout images showed that the stomach was bloated with gas and occupied the left thoracic cavity. The mediastinal structures were shifted to the right (Fig. 1). Coronal images of the torso PMCT showed abdominal organs herniated into the left thoracic cavity. The herniated organs involved the lower section of the esophagus up to the entire stomach, the left side of the transverse colon, the entire spleen, and the tail of the pancreas. The stomach exhibited a mesentero-axial volvulus and was markedly expanded. PMCT estimated the total stomach volume was 1644 ml, involving 1532 ml of intragastric fluids and 122 ml of the air. The expanded stomach compressed the mediastinum to the right side and depressed the diaphragmatic contour (Fig. 1(b)). Axial images of the thorax PMCT on the lung window setting revealed the ipsilateral lung was compressed by the stomach and the contralateral lung was pushed to the lateral margin of the cavity. The bilateral lungs were severely atelectatic and congested (Fig. 1(c)).

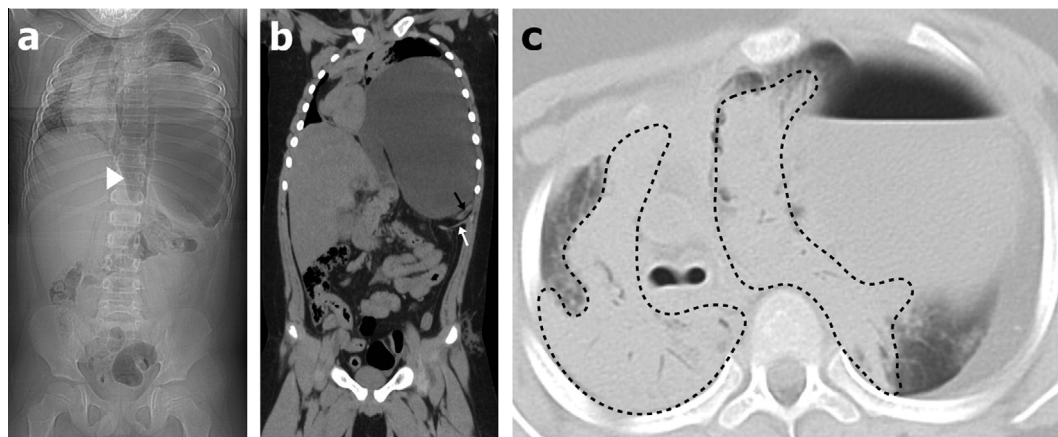
A medicolegal autopsy was performed 32 h postmortem. The body was well-developed and obese, weighing 37.0 kg, with a height of 118 cm (Body mass index 26.57 kg/m<sup>2</sup>). External examination revealed the face and anterior cervical region were suffused. There were no external injuries on the skin surface of the abdomen. Internal examination revealed the lower section of the esophagus, the entire stomach, the left side of the transverse colon, the entire

spleen (60.5 g), and the tail of the pancreas were intrathoracic, which was consistent with the PMCT findings (Fig. 2). The transverse colon and the spleen were adherent to the left posterolateral thoracic cavity. The body of the stomach was inverted and massively expanded. The stomach lumen contained 900 ml of partial digested fluid materials and the air. The gastric mucosa on twisted part was macroscopically intact and was not exhibited any significant changes such as hemorrhage, necrosis, and inflammation. The mediastinum and the lungs were displaced by the expanded stomach, which was consistent with the PMCT findings. There were petechial hemorrhages on the surface of pericardium and epicardium. The lungs were significantly edematous. In contrast to the right lung (275 g), the left lung (135 g) was flattened and reduced in volume. Inspection of the lungs revealed that there were fewer bronchial branches in the left lung than the right. The heart (125 g) was displaced and showed unremarkable valves and chambers. The right ventricle was minimally dilated. The left ventricular free wall measured 1.1 cm and the right ventricle measured 0.4 cm. An oval defect was noted on the left diaphragm at the posterolateral diaphragmatic dome. The defect was 5.0 cm in diameter with a rounded and regular edge (Fig. 3). There were no significant pathological features on other viscera.

A histological examination revealed that the bilateral lungs were severely atelectatic and congested. Myocardial fibers of the right ventricle showed normal thickness. With masson-trichrome staining, the margin of the Bochdalek defect showed collagen fibers regularly smothered in a thick layer on the surface of the diaphragmatic muscle. The cause of death was determined to be tension gastrothorax as a result of a Bochdalek hernia complicated by AGV.

### 3. Discussion

CDH refers to a protrusion of abdominal organs into the thoracic cavity through diaphragmatic defects [1–3,5–7]. CDHs are classified into three categories: posterolateral (Bochdalek); anterior parasternal (Morgagni); and central (septum transversum) [13]. Most cases of diaphragmatic defects involve a Bochdalek hernia (85–95%) [3,6]. This condition is commonly found in neonates due to life-threatening respiratory distress. A few asymptomatic cases are missed until childhood or later, and these cases are known as late presenting Bochdalek hernia. In these cases, abnormal developed lungs cause degenerative pulmonary hypoplasia and persistent pulmonary hypertension [14]. The gross pathological findings of late presentation show lungs that are physically



**Fig. 1.** Scout, coronal and axial PMCT images. (a) PMCT scout image shows the stomach is bloated with gas and occupies the left thoracic cavity. The mediastinal structures are shifted to the right side. A white arrowhead indicates the pylorus. (b) Coronal PMCT image of the torso shows a mesentero-axial gastric volvulus with intragastric fluid accumulation. The expanded stomach compresses the mediastinum and depresses the diaphragmatic contour (white arrow). The transverse colon (black arrow) is above the diaphragm. (c) Axial images of the thoracic PMCT on the lung window setting shows that the bilateral lungs are severely atelectatic and congested (black dashed lines). The ipsilateral lung is compressed by the stomach and the contralateral lung is pushed to the lateral margin of the cavity.

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