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A review of types and complications of thoracic hernias on imaging

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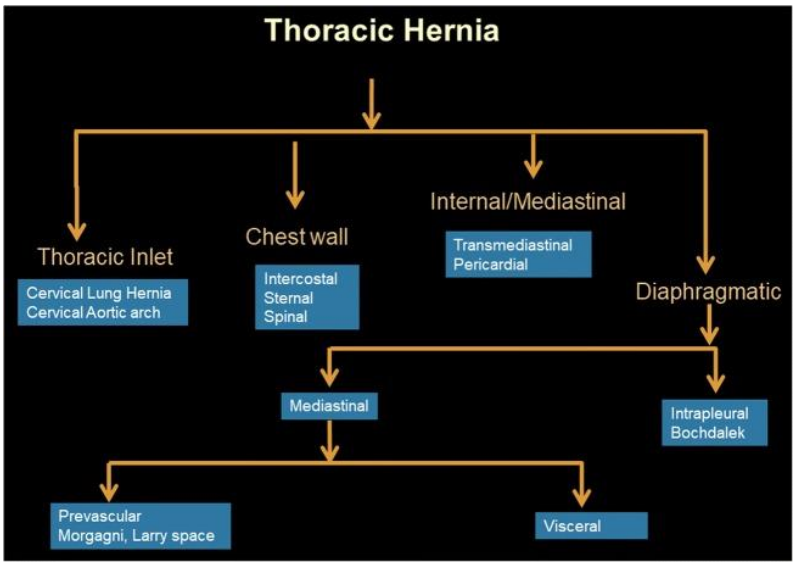
Abstract: **Thoracic hernias are characterized through either protrusion of the thoracic contents out of their ordinary anatomical confines or extension of the abdominal contents inside the thorax. Thoracic hernias can be either congenital or acquired in etiology. They are able to arise at the level of the thoracic inlet, chest wall or diaphragm. Thoracic hernias can be symptomatic or fortuitously observed on imaging received for other indicators. Headaches of thoracic hernias include incarceration, trauma and strangulation with necrosis. More than one imaging modalities are available to evaluate thoracic hernias. Radiographs generally offer the first clue to the diagnosis. Higher gastrointestinal radiography can perceive bowel herniation and associated complications. CT and once in a while MR can be useful for further assessment of these abnormalities, appropriately figuring out the kind of hernia, its contents, associated complications, and offer a roadmap for surgical planning. In this article, we review the one-of-a-kind forms of thoracic hernias and the position of imaging within the assessment of these hernias.**

Keywords: **Thoracic hernias, thoracic contents, etiology, thoracic inlet.**

1. INTRODUCTION

Thoracic hernias are characterized by means of both protrusion of the thoracic contents out of doors their normal anatomical confines or extension of the abdominal contents into the thorax. Thoracic hernias can be congenital or acquired in etiology. whilst obtained, those are generally publish-annoying or publish-surgical (Fig. 1). they could arise at the extent of the thoracic inlet, chest wall or diaphragm . Diaphragmetic hernias may be either mediastinal or intrapleural.

Those hernias may be symptomatic or incidentally detected at some stage in recurring imaging of the chest or stomach for different warning signs. Headaches of thoracic hernias consist of incarceration, trauma and strangulation with necrosis. Those headaches can mimic cardiovascular or gastrointestinal causes of chest and stomach pain, a number of which often necessitate pressing intervention or surgical operation.



2. IMAGING THORACIC HERNIAS

Exclusive imaging modalities can be useful in identification of thoracic hernias, with their blessings and downsides,which includes radiographs, top gastrointestinal collection, ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI).

The jobs of imaging inside the assessment of hernias encompass organising the analysis, characterising the type, delineating the quantity, identifying the contents, detecting complications and offering a roadmap for intervention/surgical operation.

Radiographs

Chest radiographs (CXR) are commonly the primary imaging modality utilized in adults with any suspected thoracic pathology and might provide the primary clue to a thoracic hernia.

Gastrointestinal tract radiography

Gastrointestinal contrast radiography under fluoroscopy is a useful modality in identifying bowel herniation into the thorax. Top gastrointestinal imaging with oral comparison (UGI) is beneficial in identity and category of the hiatal hernias. Lower gastrointestinal radiography (contrast enema) is useful in identifying herniation of the large bowel into the thorax and complications of massive bowel conduits. In patients with suspected bowel perforation, water-soluble evaluation is first of all used for both UGI and enema examinations. At our institution, low osmolar non-ionic comparison which include iohexol 350 mgI/ml (Omnipaque 350, GE Healthcare, Princeton, NJ, u.s.a.) in adults and Optiray 240 (Ioversol 240 mgI/ml, Guerbet LLC, Bloomington, IN, u.s.) in youngsters < 17 years is used. We restriction the usage of oral barium to assessing any leaks in patients with large frame habitus or overlying steel hardware while pix with water-soluble or low-osmolar sellers are suboptimal. A few radiologists decide on no longer to use barium sulfate in younger or debilitated older patients who can be at hazard for aspiration or can also need additional imaging.

Ultrasound

Ultrasound (US) is the modality of choice inside the prenatal assessment of congenital malformations and may discover congenital diaphragmatic hernias. It is able to be used inside the paediatric age institution, wherein the radiation dose is a difficulty. It's far portable, cheaper and extensively available and gives real-time statistics. US can be a useful modality to affirm a superficial thoracic hernia.

Computed tomography

CT is the pass-sectional imaging modality of preference within the identity and characterisation of thoracic hernias in adults. CT correctly identifies and classifies thoracic hernias in addition to the contents of the hernia sac. On CT, the dimensions of the hernia sac and size of the illness can be measured. CT is likewise useful for assessment of any related headaches. The modern multidetector CT (≥ sixteen detector rows) yields isotropic voxels that may be displayed in more than one exceptional planes. Photo analysis of these axial CT images can generate 3-dimensional, volume- or surface-rendered pictures as well as minimum- and maximum-depth projections for a more comprehensive evaluate of the hernias. Maximum thoracic hernias can be identified and categorised on a unmarried venous phase evaluation-more desirable CT of the thorax. In our exercise, we use oral assessment in those patients who have suspected bowel herniation or who also are present process a concurrent stomach CT.

Magnetic resonance imaging

MRI can identify non-acute pericardial and diaphragmatic hernias. MRI with out intravenous evaluation can characterise the hernia in sufferers who can not acquire evaluation for CT (renal failure, history of anaphylaxis after previous evaluation medium management, and many others.). Multiple acquisitions can be received, that could help characterise herniation of the abdominal contents inclusive of the liver or spleen because those may be suboptimally characterized on a single-segment comparison-more suitable CT examination. Steady-state unfastened-precession sequences are used to discover in utero foetal congenital diaphragmatic hernias. T2-weighted axial, coronal and sagittal photos are useful in figuring out defects inside the diaphragm or the chest wall. Evaluation-enhanced photos after injection of intravenous gadolinium can characterise contents of the hernia sac and additionally examine for any complications within the

herniated stable viscera. Time-resolved dynamic imaging at some stage in thought, expiration and the Valsalva manoeuvre can be beneficial to reveal modifications within the hernia with unique stomach or intrathoracic pressures.

Thoracic hernias

Hernias on the advanced thoracic aperture

The superior thoracic aperture is formed by way of the manubrium, each the primary ribs and the primary thoracic vertebra. The lung apices are included by using the apical parietal pleura and Sibson fascia, which extends from C7 to the first ribs. Apices of the lungs make bigger handiest for about 2.5–5 cm superior to the superior border of the sternal give up of the primary rib. Any extension of the thoracic contents above the thoracic inlet constitutes cervical or apical hernia.

Cervical lung herniation

Herniation of the lungs inside the cervical place is uncommon and commonly described in case reports. Lung hernias may be cervical, thoracic or diaphragmatic. Cervical hernias may be seen in kids (about 5 yr olds and elder)with allergies, in adults with obstructive lung disease and after surgery or trauma. Submit-traumatic hernia can form as a sequela of tears in the Sibson fascia with a nicely-described hernia sac. Hernia can be due to chronically increased intrathoracic pressure gift as laxity of the suprapleural membrane with no hernia sac. Those may be unilateral or bilateral.

On radiographs, unilateral cervical lung hernia is seen as a unilateral lucency at the level of the thoracic inlet with contralateral tracheal deviation. Postoperative subcutaneous emphysema can mimic a cervical lung hernia but may be differentiated on CT. Asymptomatic supraclavicular lung hernias do not require surgical restore and maximum paediatric hernias solve spontaneously. Surgical repair of the hernias may be essential whilst complications are present, inclusive of neurological ache from neural compression.

Cervical aortic arch

Cervical aortic arch is a unprecedented congenital anomaly wherein the aortic arch extends into the tender tissues of the neck. The aortic arch usually develops from the right fourth branchial arch. however, in cervical aortic arch, it develops from the 0.33 arch, with the fourth arch being atretic .

Cervical aortic arch is greater commonplace on the left. Cervical aortic arch can gift as a pulsatile supraclavicular mass. On CT and MRI, the arch extends above the sternum into the cervical vicinity. this could dilate and shape an aneurysm. Dilation can be due to bizarre development, bizarre connective tissue or altered haemodynamics with excessive aortic wall pressure and trauma. Cervical aortic arch aneurysms are treated with endovascular restore or the usage of an interposition graft after sternotomy.

Chest wall hernia

The chest wall is constructed from pores and skin, superficial fascia, deep fascia, muscles and the thoracic skeleton (ribs, sternum, clavicle, scapula and vertebral our bodies). The intercostal area has three intercostal muscular tissues (external, internal and innermost), which are skinny or deficient, anteriorly near the sternum and posteriorly close to the vertebral bodies. There's a further pleural area, which lies among the internal floor of the ribs and the parietal pleura. The chest wall hernias can be intercostal, sternal or spinal in area.

Intercostal lung hernia

Intercostal lung hernia is a protrusion of the lung parenchyma ,a defect in the chest wall. Only a few instances were mentioned within the literature on those hernias. Intercostal lung hernia may be congenital (related to costal cartilage defect or rib hypoplasia), spontaneous (unexpected growth in intrathoracic pressure inclusive of during coughing, sneezing, blowing a musical gadgets, and many others.) or, more typically, secondary to trauma or insufficient restoration after thoracic surgical procedure (thoracotomy, thoracoscopy, minimally invasive cardiac surgery). Lung is the most commonplace content of an intercostal hernia sac. Intercostal hernia can be asymptomatic or gift with localised chest ache in patients with previous thoracotomy or chest tube placement.

Intercostal hernia of the abdomen viscera

Abdominal intercostal hernia is an extraordinary received hernia happening via defects within the diaphragm and adjoining intercostal muscle tissues. It is also secondary to penetrating or blunt thoracoabdominal accidents and may be visible in sufferers with COPD, osteoporosis and muscle weakness. Those can occur even after minor activities along with coughing or heavy lifting. Clinically, those hernias may be easily diagnosed because of their superficial tender tissue region however these can be overlooked on CXR. The liver can herniate at the proper and spleen or peritoneum at the left facet.

Sternal dehiscence and hernia

Sternal dehiscence is a rare but grave trouble of cardiac surgical treatment. It represents separation of the bony sternum and may arise in zero.2–five% of sufferers after median sternotomy. It may be due to primary non-union, poor wound recovery or untimely overexertion and can be associated with infections and mediastinitis. Early dehiscence is hard to discover clinically. Cardiovascular structures typically herniate through the dehiscence. Gastric herniation has additionally been suggested , mainly an average sternotomy that extends into the epigastric place and weakens the upper anterior abdominal wall.

On CXR, altered configuration of sternal wires can be suggestive of impending dehiscence . En bloc displacement of the wires indicates gross separation of sternal margins. A mid sternal stripe thicker than 3 mm on CXR is also suggestive of sternal dehiscence . The aorta, pulmonary artery, right ventricle or proper ventricular outflow tract can herniate through the sternal dehiscence and may be identified on CT or MRI. A thin layer of pericardium, subcutaneous fat and pores and skin overlies the myocardium, supplying insufficient insurance with hazard of myocardial injury with even minor trauma. Sternal debridement with flap coverage constitutes the mainstay of therapy .

The immunological and angiogenic properties of a greater omental graft render it useful for treatment of mediastinitis and wound infection. Mediastinal placement of the more omentum represents an obtained hernia because the omentum is harvested from the stomach and repositioned into the thorax through a surgically created transdiaphragmatic commencing. Omental grafts are from time to time extensively utilized to buttress a publish-pneumonectomy bronchial stump and to fill within the put up-pneumonectomy area.

Pericardial hernia

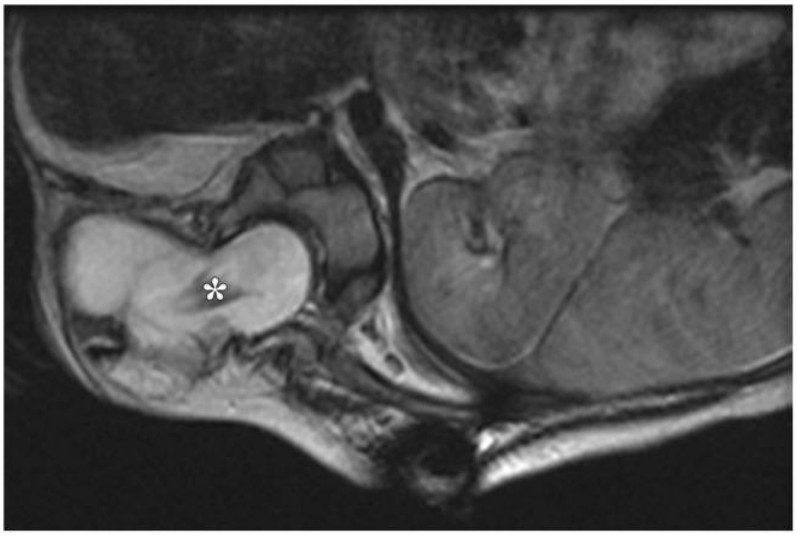
Pericardial defects may be congenital or obtained after pericardiectomy, lung or cardiac transplant or trauma. It is able to be both whole or partial. The incidence of congenital pericardial defects is suggested to be < 1 according to 10,000 based totally on autopsies. Congenital absence of the pericardium effects from extraordinary early regression of the not unusual cardinal vein, which results in incomplete formation of the pleuropericardial membrane. Pericardial tears in blunt trauma maximum generally occur alongside the left pleuropericardium parallel to the area of the phrenic nerve . The proper incidence of pericardial defects is possibly underreported as many instances might also continue to be asymptomatic . Although congenital entire left-side defects are extra commonplace, partial defects tend to be symptomatic and feature a better incidence of complications. With a partial illness there can be herniation of the lung parenchyma into the pericardial illness. On imaging lung herniation may be identified among the ascending thoracic aorta and most important pulmonary artery .

Focal herniation of cardiac chambers also can occur through such partial defects. The maximum common cardiac chamber to herniate is the left atrial appendage. The herniation is greater prominent during systole.

Spinal hernia

The contents of the spinal canal can herniate into the chest wall, pleura or posterior mediastinum, forming an intrathoracic meningocele . Congenital meningocele is visible in patients with neurofibromatosis, even as received meningocele takes place after laminectomy or associated with musculoskeletal deformities . Those are regularly asymptomatic. CXR can identify a tender tissue lesion within the posterior mediastinum. On CT and MRI, the herniation of meninges and CSF through an intervertebral foramen with cyst formation can be recognized . MRI is advanced to CT in identity of the neural placode, which is present in myelomeningoceles however not in meningoceles.

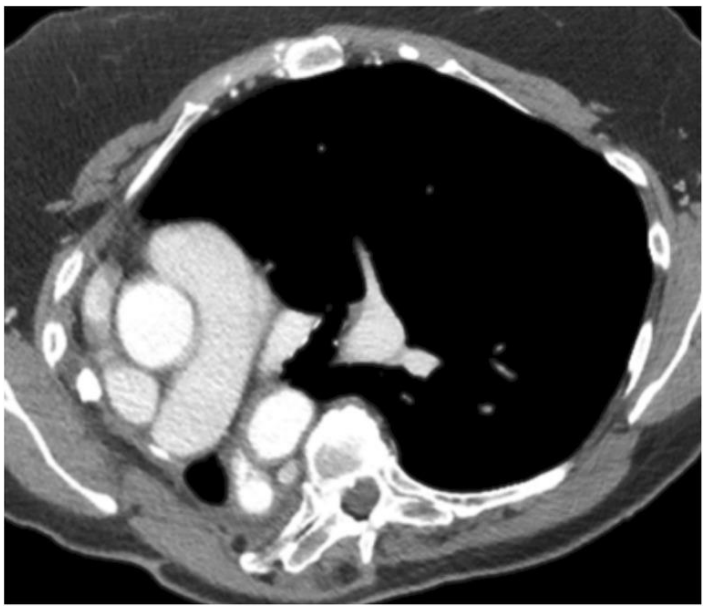
(pic 1a)



Transmediastinal hernia

Transmediastinal hernia refers to the herniation of the pleural sac and its contents throughout the mediastinum to the opposite aspect. This entity is wonderful from mediastinal displacement wherein the entire mediastinum shifts in the direction of one hemithorax. Herniation of the lung may be visible in patients with sequestration, scimitar syndrome or post pneumonectomy and usually takes place across the anterior mediastinum, while herniation of the pleural sac and fluid commonly takes place throughout the posterior inferior mediastinum . Trans-mediastinal herniation of the large bulla has additionally been described.

On CXR, the anterior junction line is displaced. At the lateral radiograph, the hernia is seen as a retrosternal lucency that could mimic an anterior pneumothorax. CT is the modality of choice and identifies displacement of either the anterior or posterior junction line with out displacement of the mediastinum. Following pneumonectomy, the publish-surgical space step by step fills with fluid with alternative of air through the years. Obliteration of the put up-pneumonectomy area and herniation of everyday lung throughout the midline generally take weeks to months . Put up-pneumonectomy syndrome is defined in children and teens after right pneumonectomy. It effects from hyperinflation of the left lung with herniation throughout the midline in the direction of the right side. This herniation results in stretching and compression of the left mainstem bronchus with narrowing of the trachea and left bronchus among the pulmonary artery and descending thoracic aorta . Tissue expanders or silicone breast implants are used within the post-pneumonectomy area to save you such transmediastinal herniation. Additional or larger implants may be wanted through the years in growing kids to deal with this entity.



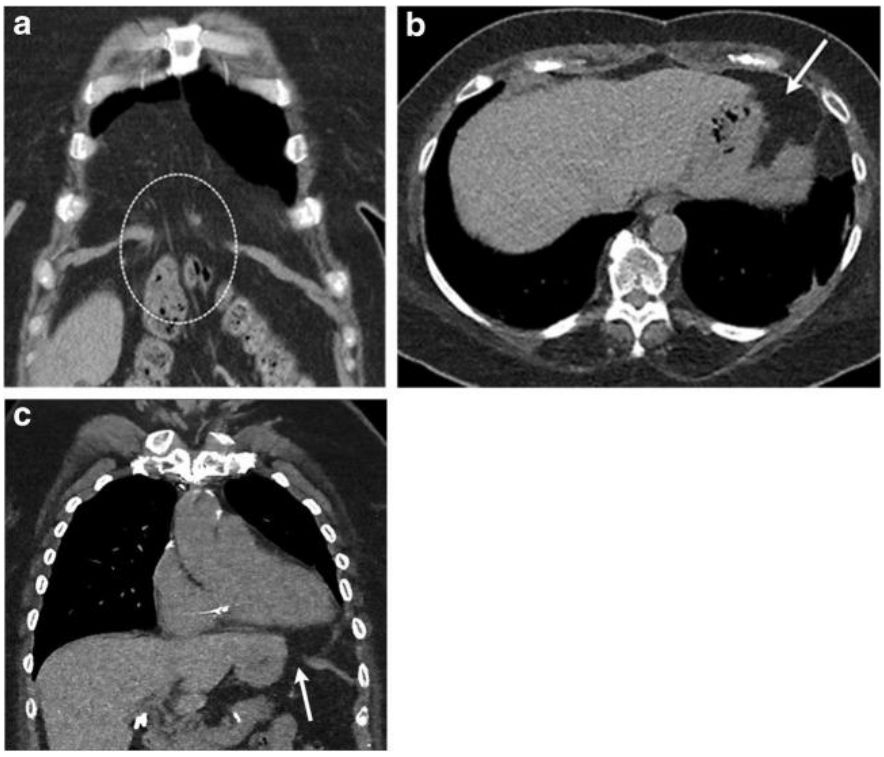
Transdiaphragmatic hernia

The diaphragm is a dome-fashioned shape with a significant tendon and circumferential muscular fibres arranged in three agencies: Pars lumbaris, pars costalis and pars sternalis. Gaps between the muscular layers are simplest protected by pleura, peritoneum and fascial layers, resulting in ability websites of weakness. Diaphragmatic hernias may be either mediastinal or intrapleural. Mediastinal trans-diaphragmatic hernias can be in the prevascular space (Morgagni and Larry's space) or visceral compartment (pericardial hernia, hiatal hernia). Bochdalek hernia is an instance of an intrapleural hernia. Post traumatic hernias might not follow those strict obstacles as they can result from tears in both the mediastinal and pleural quantities of the diaphragm.

Morgagni hernia

A Morgagni hernia is characterized by means of a small anatomical illness in the space between the pars costalis and pars sternalis at the proper aspect of the diaphragm. This capacity space, additionally known as the sternocostal triangle, is bordered by means of the sternum, diaphragm and pericardium and consists of internal thoracic vessels and lymphatics. The occurrence of congenital Morgagni hernias is < 3% of live births and 12% of diaphragmatic defects diagnosed in infancy. A comparable gap on the left facet of the diaphragm is Larry's area . No matter laterality, these are referred to as Morgagni hernias.

On CXR, a Morgagni hernia provides as an opacity inside the cardiophrenic perspective. Differential diagnosis includes a outstanding fats pad, lymphadenopathy, and bronchogenic or pericardial cyst. On CT, the defect within the sternocostal triangle is commonly diagnosed containing the omentum in adults, but it may include the liver, bowel loops or stomach in youngsters. MRI is used in hard instances and distinguishes herniated contents as liver vs. mass or metastasis.

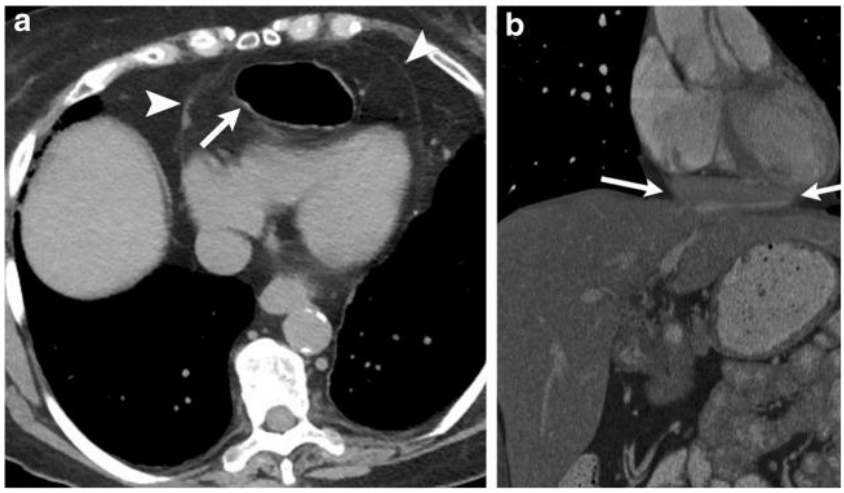


Intrapericardial diaphragmatic hernias

Intrapericardial diaphragmatic hernias are uncommon and typically the sequelae of indirect blunt trauma. Belly contents can herniate into the pericardium through such tears. CXR can discover retrosternal air or bowel loops. CT can verify the herniated belly or different bowel loops. Liver can herniate into the pericardium and mimic a pericardial mass on echocardiography. CT with comparison can correctly pick out the herniated viscera which includes liver. MRI has high spatial and temporal resolution and might aid now not only in characterising this sort of pericardial mass but additionally in evaluating for any related pericardial constraint.

Hiatal hernia (HH) represents herniation of the stomach into the thorax via a defect in the oesophageal hiatus. Hiatal hernias are the most not unusual diaphragmatic hernias in adults.

It's miles anticipated that greater than 50% of adults within the western populace with > 50 years of age have these hernias.



There are 4 forms of hiatal hernias; those can be identified on UGI, CT, and MRI. Type I or sliding hiatal hernia represents the maximum commonplace type in which there may be intrathoracic migration of the gastro-oesophageal junction because of weak spot of the phrenico-oesophageal membrane. In kind II HH, the gastro-oesophageal junction remains beneath the diaphragm, while the gastric fundus herniates into the thorax from a focal illness within the phrenico-oesophageal membrane. Type III HHs are compound hernias wherein the phrenico-oesophageal membrane is not only weakened and stretched, however there is additionally a defect inside the anterolateral portion of this membrane. This results in herniation of the gastro-oesophageal junction and gastric fundus into the thorax. These are the maximum commonplace form of para-oesophageal hernias and can be associated with gastric rotation. Type IV hernia is characterized by using kind III hernia at the side of herniation of other stomach organs, that could encompass the pancreas, spleen and liver .

Bochdalek hernia

Bochdalek hernia happens through defects in the pars lumbaris and pars costalis and is more commonplace at the left side. Those are the commonplace for congenital diaphragmatic hernias, with an expected prevalence of one consistent with 2000–5000 live births. In adults, Bochdalek hernias are frequently underreported and may be recognized in zero.17% to six% of patients with hernias represent defects or tears inside the diaphragm. Diaphragmatic hernias with larger defects have a better likelihood of being acquired after blunt trauma or a energetic bout of coughing in a paralysed or thin hemidiaphragm in preference to being congenital defects in the diaphragm.

These hernias can be diagnosed on recurring prenatal US while stomach or bowel loops are seen inside the thorax. Prenatal MRI is useful in confirming the defects and assessing for lung maturity. They can be associated with ipsilateral lung hypoplasia. Typically the belly contents extend throughout the diaphragm into the thorax because of higher intra-stomach pressure. Large defects in the diaphragm can lead to herniation of the bowel loops and omentum into the mediastinum.

Post-demanding diaphragmatic hernia

Diaphragmatic harm because of blunt trauma can lead to complex tears that can be inside the valuable tendon and/or muscular fibres. This can result in herniation of stomach contents into the thorax; this regularly remains clinically occult but is by the way diagnosed on CT or MRI. The signs on CT to assess diaphragmatic injury may be direct or oblique.

Directs symptoms are:

Segmental diaphragmatic disorder: when there is a focal loss of continuity in the diaphragm.

Dangling diaphragm signal: inward curling of the free fringe of the torn diaphragm. This paperwork a smooth tissue attenuation curvilinear shape.

Absent diaphragm sign: absence of the hemidiaphragm in a location in which the diaphragm is expected to be absolutely identifiable.

Indirect or Oblique symptoms are:

Herniation of abdominal organs or peritoneal fat into the pleural or pericardial space.

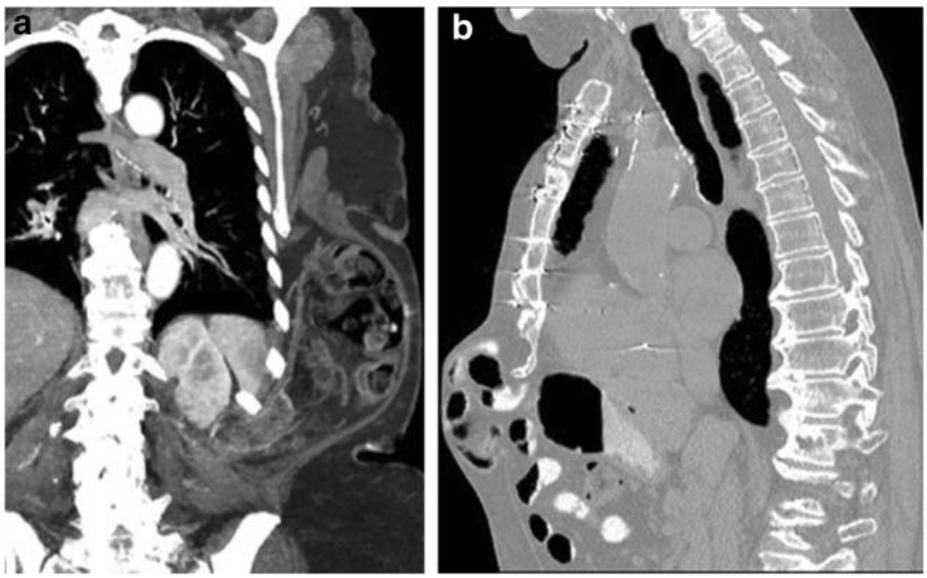
Collar sign: Waist-like constriction of the herniated structure at the website online of the diaphragmatic disorder. A variation of the collar sign is the hump sign, which refers to the shape of the herniated liver located above the level of the diaphragm. On axial CT photos, the band sign may be seen, which corresponds to a linear hypoattenuation that transects the herniated liver among the rims of the diaphragm.

Established viscera signal: This represents direct touch among the herniated stomach organs and the chest wall, with none interposition of the lungs.

Elevated abdominal organs sign: This is produced via the displacement of abdominal systems above the level of the hemidiaphragm. Nchimi et al. proposed the use of a right hemidiaphragmatic elevation > 5 cm above the level of the left hemidiaphragm as a threshold for proper-sided and a left hemidiaphragmatic elevation > 4cm above the extent of the proper hemidiaphragm as a threshold for left-sided diaphragmatic rupture.

Thoracic extension of stomach wall hernia

These can amplify above the extent of the diaphragm through the superficial or deep layers of the thorax and present as a superficial chest wall hernia. These hernias can originate from both the ventral or the lateral stomach wall. Lumbar hernias arise through defects among the 12th rib and iliac crest and are normally sequelae of prior trauma or surgery. Incisional hernias are seen in the midline anterior stomach wall, commonly as a overdue trouble of belly surgical treatment.



Complications of thoracic hernias

Headaches of thoracic hernias encompass trauma, obstruction, incarceration and strangulation. The herniated contents in a chest wall hernia are also at accelerated danger of harm from minor trauma. Obstruction can be visible in herniated bowel loops or stomach. Incarcerated hernia is characterised with the aid of an irreducible hernia due to a slender neck and suggests that the contents of the hernia sac are irreducible.

Incarceration predisposes to strangulation and obstruction in cases with bowel herniation. To begin with there may be angulation and distortion of the lymphatics accompanied by way of veins and arteries at the level of the neck of the hernia, that could reason lymphatic and venous obstruction. On CT, the herniated viscera can appear enlarged, oedematous, hypodense and with reduced assessment enhancement. If left untreated, this may lead to finish arterial occlusion and strangulation. A strangulated hernia with arterial occlusion desires to be dealt with emergency basis; otherwise it will lead to ischaemia and necrosis.

The headaches of thoracic hernias can be first-rate described in phrases of the hernia contents.

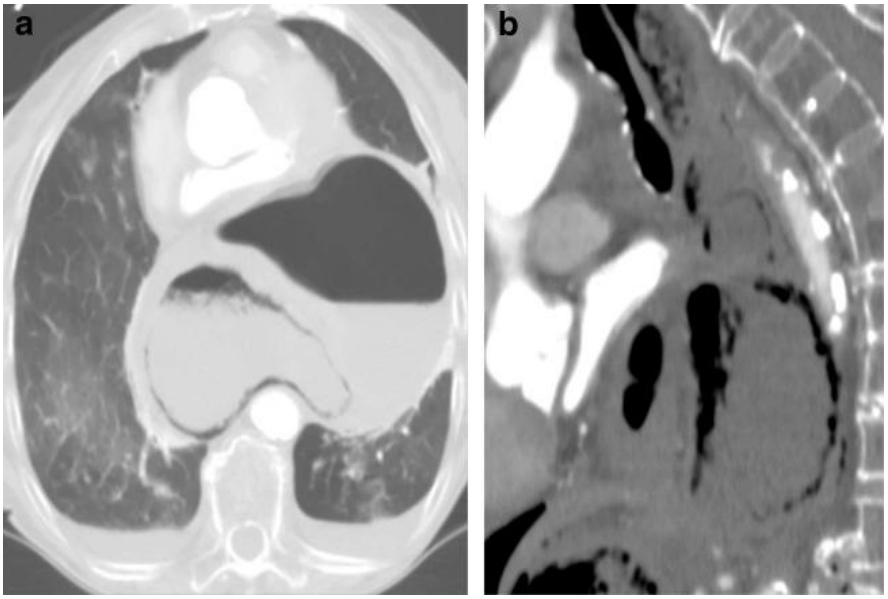
Lung:

Incarcerated lung hernia provides as a non-reducible, well-circumscribed bulge. On CT, alternate within the calibre of the airlines or abrupt narrowing of the pulmonary vessels shows impending strangulation of the herniated lung. Strangulation of lung parenchyma is uncommon however has been described in case reviews . Abrupt narrowing of the bronchi or trade inside the calibre of the pulmonary vessels on the neck of the hernia may be signs and symptoms suggestive of drawing close strangulation on CT. Thrombus may be present in pulmonary arterial branches leading to a strangulated lung phase.

Stomach:

Pain of a herniated stomach encompass incarceration, strangulation and volvulus. Gastric volvulus can be either organoaxial or mesentroaxial. In organoaxial volvulus, the rotation happens along the lengthy axis of the stomach, while in mesentroaxial volvulus the rotation is perpendicular to the lengthy axis of the stomach with the displaced antrum being superior to the GE junction. Gastric rotation or a twist > a hundred and eighty° can result in strangulation and obstruction. Organoaxial volvulus is greater commonplace in hiatal hernia and has a high occurrence of strangulation and necrosis. Organoaxial positioning of the stomach refers to partial rotation < a hundred and eighty° with out gastric obstruction.

On CXR, retrocardiac air fluid stages may be visible. On UGI, findings diagnostic of an organoaxial volvulus encompass an intrathoracic stomach with an inferior function of the GE junction and inferiorly directed pylorus with a opposite function of the greater and lesser curvatures. Further, incapability to bypass the orogastric tube or failure inside the passage of oral assessment past the stomach indicates rotation > one hundred eighty° and gastric obstruction. Frequently CT is received before UGI and might pick out the herniated intrathoracic stomach and pneumatosis and locate the transition point of the gastric obstruction. Evaluation-greater CT also can discover reduced enhancement in the gastric wall due to hypoperfusion and strangulation.



Bowel:

The herniated bowel can undergo a closed loop obstruction. In such cases, CT can become aware of bowel wall thickening, peculiar wall enhancement, engorgement of vessels and pneumatosis. Presence of free fluid, bowel wall thickening and distention represents impeding strangulation. In sufferers with continual hernia, adhesions can form in the hernia sac with fibrosis. This will lead to slowly revolutionary obstruction of the herniated belly or bowel loops, that may gift as acute-on-continual obstruction.

3. CONCLUSION

Thoracic hernias can occur on the thoracic inlet, chest wall or diaphragm. Imaging, in particular CT, performs an crucial role in setting up the prognosis, characterising the type, delineating the quantity, identifying the content, detecting complications and offering a roadmap for interventions.

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