Fat lesions in the chest: Differential diagnosis

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Learning objectives

To discuss and illustrate the various imaging characteristics of fat-containing lesions that manifest in endobronchial, parenchymal, mediastinal, cardiac, and pleural locations. We also describe intrathoracic herniations that contain fat.

Background

Although most lesions that occur in the chest have a nonspecific soft tissue appearance, fat-containing lesions are occasionally encountered at cross-sectional computed tomography (CT) or magnetic resonance imaging. Fat detection is always a useful clue to the radiologist. Any lesion at any location with fat inside it will help radiologists to make shorter and more precise differential diagnosis.

Imaging findings OR Procedure details

1) Endobronchial and Parenchymal Lesions

Lipoma

The vast majority of bronchial lipomas arise centrally from fatty tissue in the wall of proximal lobar or segmental bronchi. Endobronchial lipomas are rare, constituting only 0.1% of all pulmonary tumors and roughly 3.2%-9.5% of all benign endobronchial tumors.

Peripheral intrapulmonary lipomas usually present as a solitary opacity on chest radiograph, indistinguishable on plain films from malignant neoplasms. They are thought to arise from fatty tissue in the walls of peripheral bronchi at subsegmental level.

At CT, lipomas are well-differentiated lesions with homogeneous fat attenuation.

Hamartoma

Hamartomas constitute roughly 8% of all lung neoplasms. Hart was the first to discover these lesions in the lung. The term is used to describe lesions in the lung that contain

myxomatous connective tissue, cartilage, epithelial lined clefts, and varying amounts of fat, smooth muscle, marrow, bone, and round cells.

Three to twenty per cent of hamartomas are endobronchial and may cause problems such as pneumonia, atelectasis, cough, hemoptysis or chest pain due to obstruction of a bronchus.

Hamartomas are typically well-circumscribed, solitary, lobulated pulmonary masses, smaller than 4 cm in diameter, previously reported to contain popcorn calcifications in 10-30% and fat in 30-50%. At CT, the reported prevalence of calcification in hamartomas varies from 5% to 50%. Fat is identified in up to 50% of hamartomas at CT and may be localized or generalized within the nodule. Intranodular fat is considered a reliable indicator of a hamartoma, and its presence may help obviate needle aspiration biopsy.

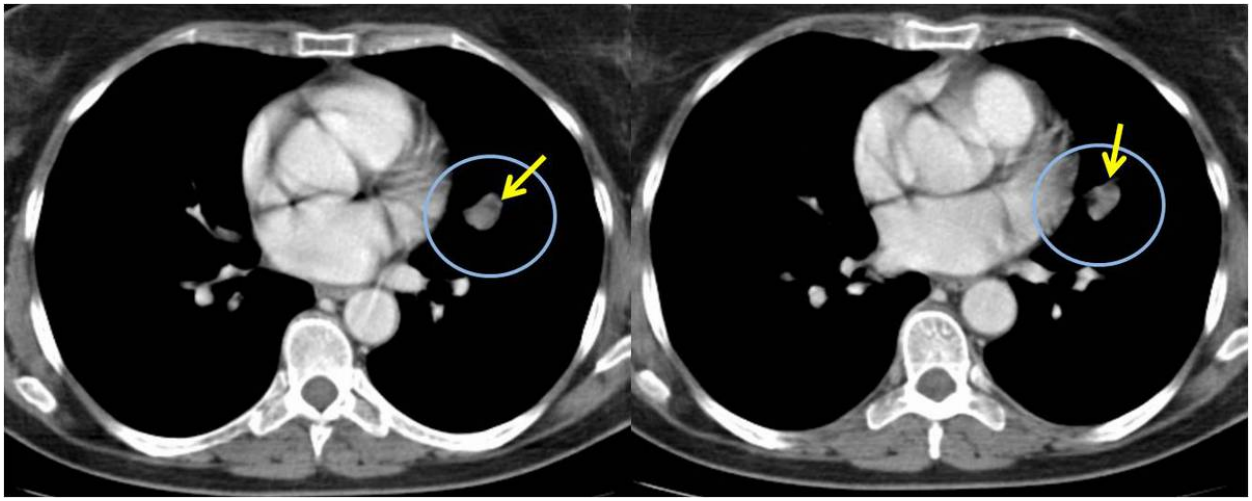

Fig.: Parenchymal hamartoma. CT scan shows a solitary pulmonary nodule containing a focus of fat attenuation.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

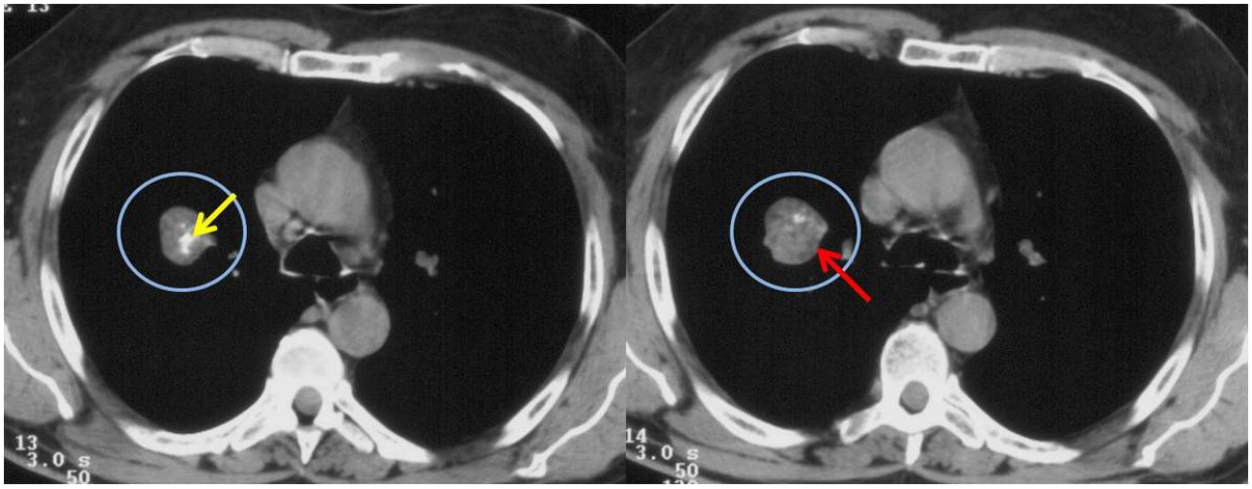

Fig.: Hamartoma. Chest CT scan images show a heterogeneous, sharply marginated lesion with focal areas of calcification (yellow arrow) and fat (red arrow). These findings are typical features of hamartoma.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Lipoid Pneumonia

Lipoid pneumonia is an uncommon condition that results from the chronic aspiration of mineral, animal, or vegetable oils into the lungs.

The most common locations for lipoid pneumonia are the dependent portions of the lungs. The characteristic CT finding is lung consolidation with fat attenuation. A "crazy-paving" pattern of septal thickening and centrilobular interstitial thickening superimposed on ground-glass attenuation has been described. Traction bronchiectasis and cystic changes consistent with fibrosis can be seen.

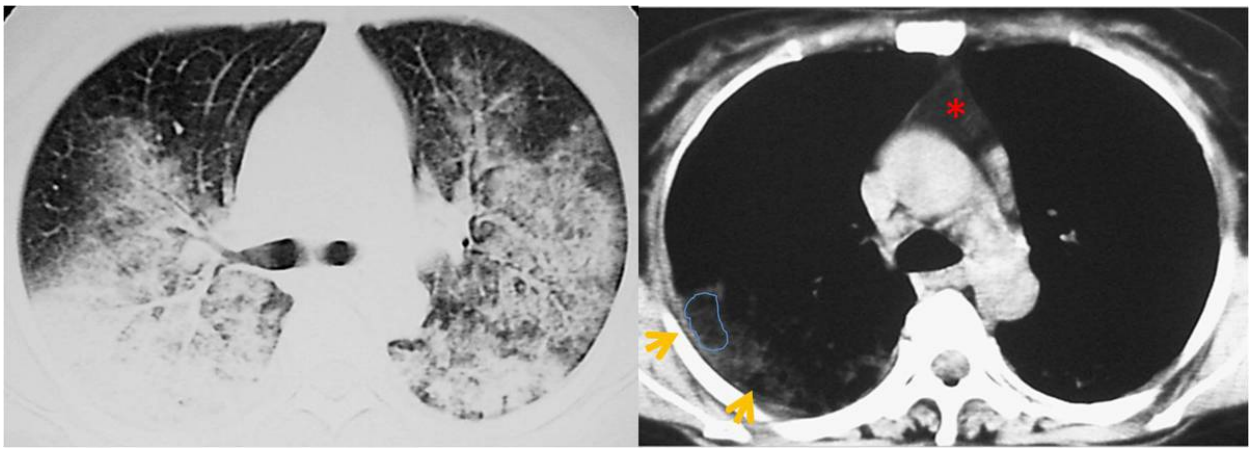

Fig.: Exogenous lipoid pneumonia resulting from chronic oil aspiration. CT (lung window) shows ill-defined parahilar ground-glass opacity and areas of consolidation in the posterior lung. Soft-tissue window scan at the same level, shows areas of low attenuation (arrows) within the consolidation. This low attenuation is similar to the mediastinum fat (*).
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

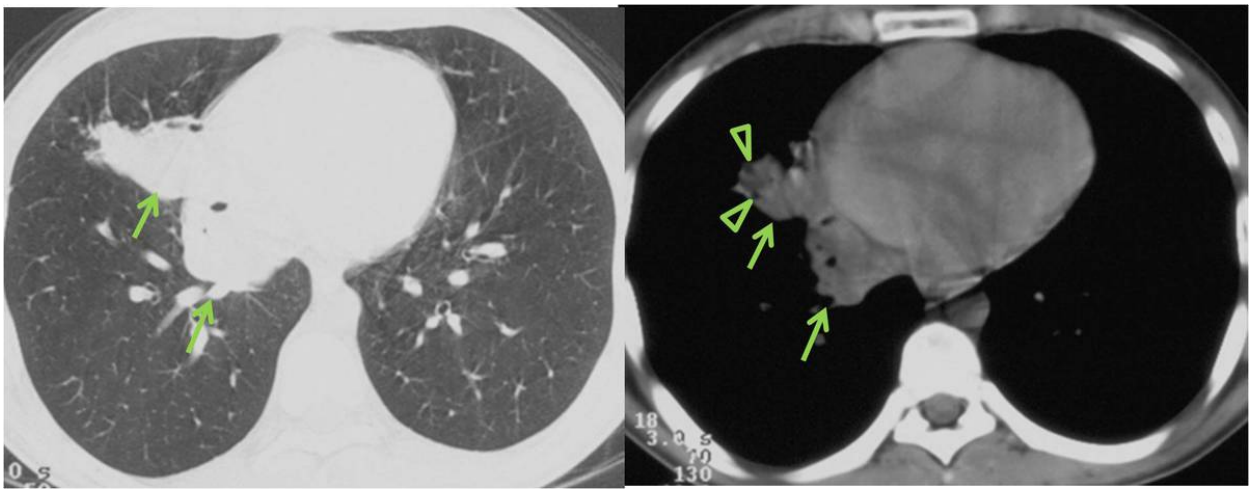

Fig.: Exogenous lipoid pneumonia resulting from chronic mineral oil aspiration. CT shows two irregular masses adjacent to the right border of the heart (arrows). The soft tissue scan shows that the masses are predominantly of soft-tissue attenuation. However there are small areas of fat attenuation inside the mass of medium lobe (arrowheads), the key finding to make the correct diagnosis.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Endogenous form

The endogenous form results from the accumulation of lipid-filled macrophages beyond a bronchial obstruction such as a lung tumor. CT may show an area of increased attenuation spreading distal to the tumor shadow corresponding to the accumulation of foamy macrophages and eosinophilic proteinaceous material.

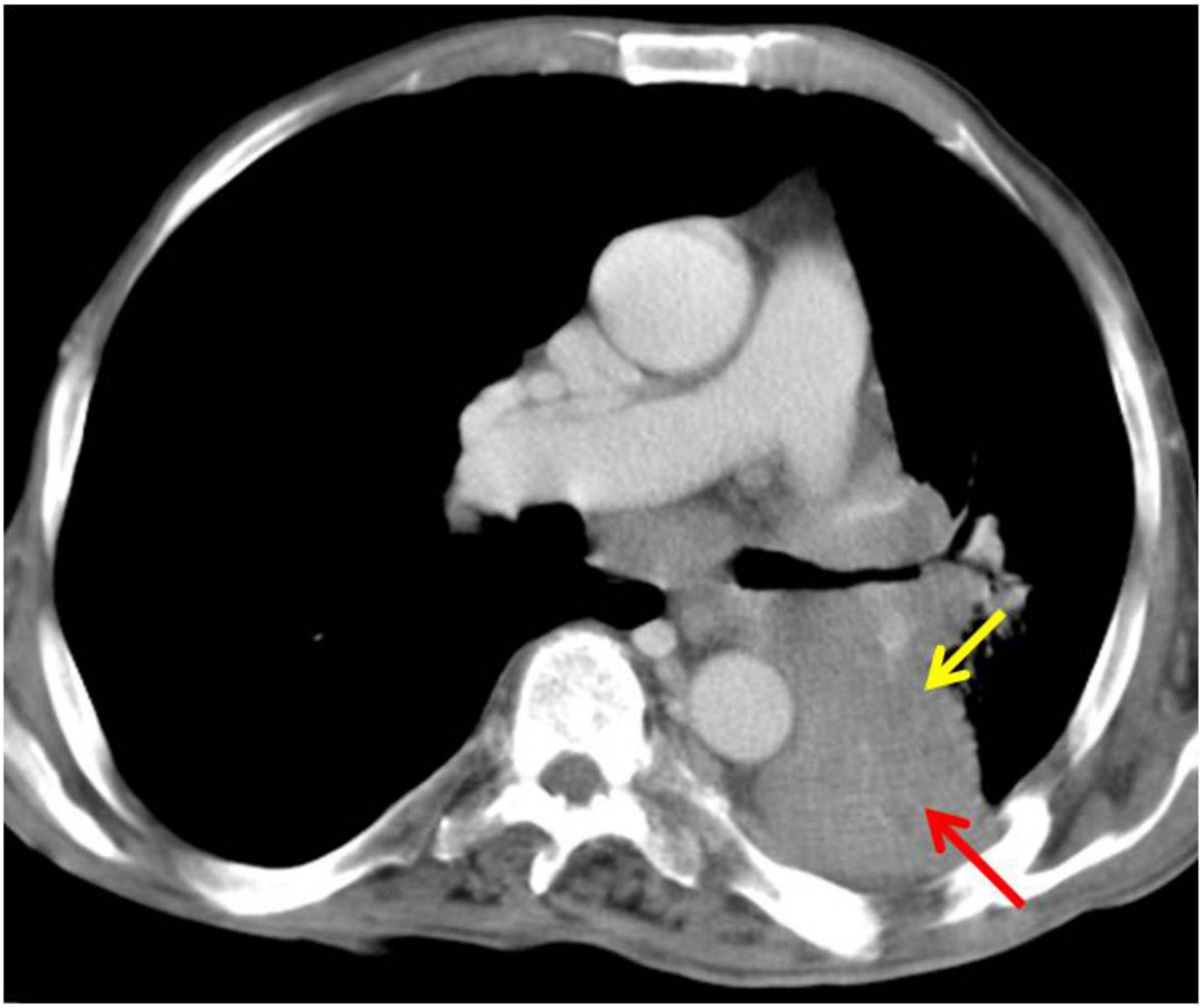

Fig.: Post-obstructive pneumonia. Patient with a central hilar mass (not shown) and post-obstructive consolidation in the lower left lobe, with discrete areas of low attenuation (arrows).
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

2) Mediastinal Lesions

The differential diagnosis of fat-containing mediastinal masses includes lipoma and liposarcoma, mediastinal lipomatosis, mediastinal fat pad, omental herniation, and mature teratoma. It may not be possible to distinguish a predominantly fatty thymolipoma from a mediastinal lipoma. The presence of loops of intestine and the continuity of the lesion with fat in the abdomen should establish the diagnosis of a hernia. Mature teratomas tend to be rounded, lobulated, cystic, anterior mediastinal masses. They are usually located in the superior mediastinum, generally do not conform to the shape

of adjacent structures, and frequently are seen to contain calcification on CT scans. Mixtures of fat, soft tissue, fluid, and calcification may be seen.

Lipomas

Lipomas occur predominantly in the anterior mediastinum and are reported to represent 1.6%-2.3% of all primary mediastinal tumors.

Commonly categorized by location as localized mediastinal (usually at the cardiodiaphragmatic angle), cervicomediastinal (extending into the neck), or transmural (penetrating the chest wall, usually in the upper anterior mediastinum).

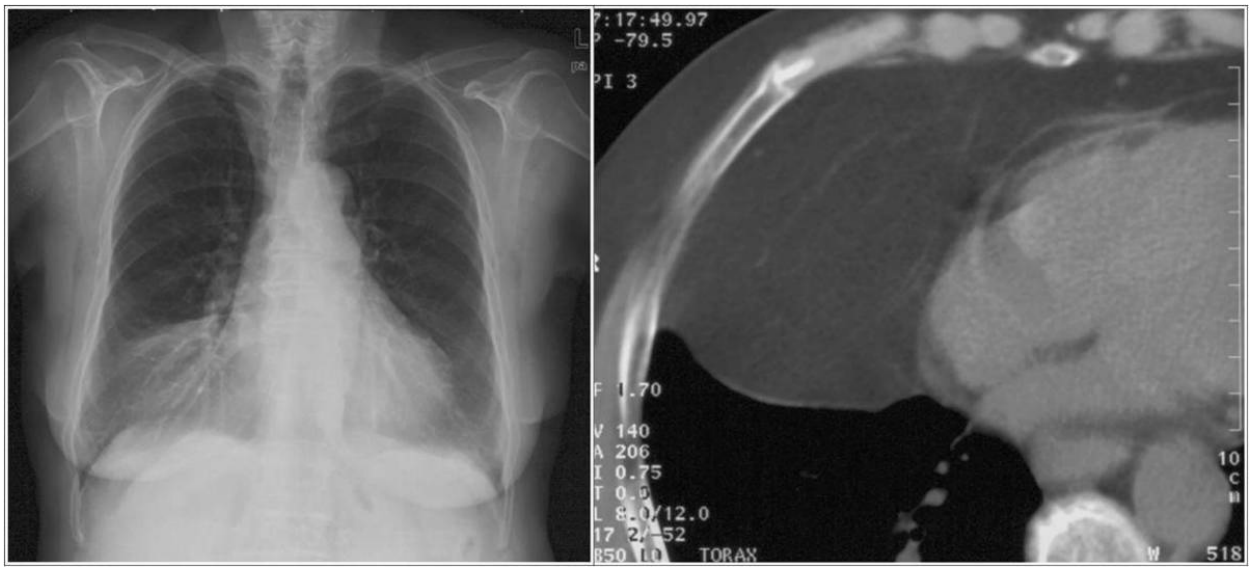

Fig.: Mediastinal lipoma. (a) Posteroanterior chest radiograph shows opacity in the inferior hemithorax with low density. (b) CT scan shows a well-demarcated fatty mass at the cardiodiaphragmatic angle.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Lipomatosis

Excessive unencapsulated infiltrative fat deposition is known as mediastinal lipomatosis. Lipomatosis is commonly associated with obesity and exogenous steroid administration.

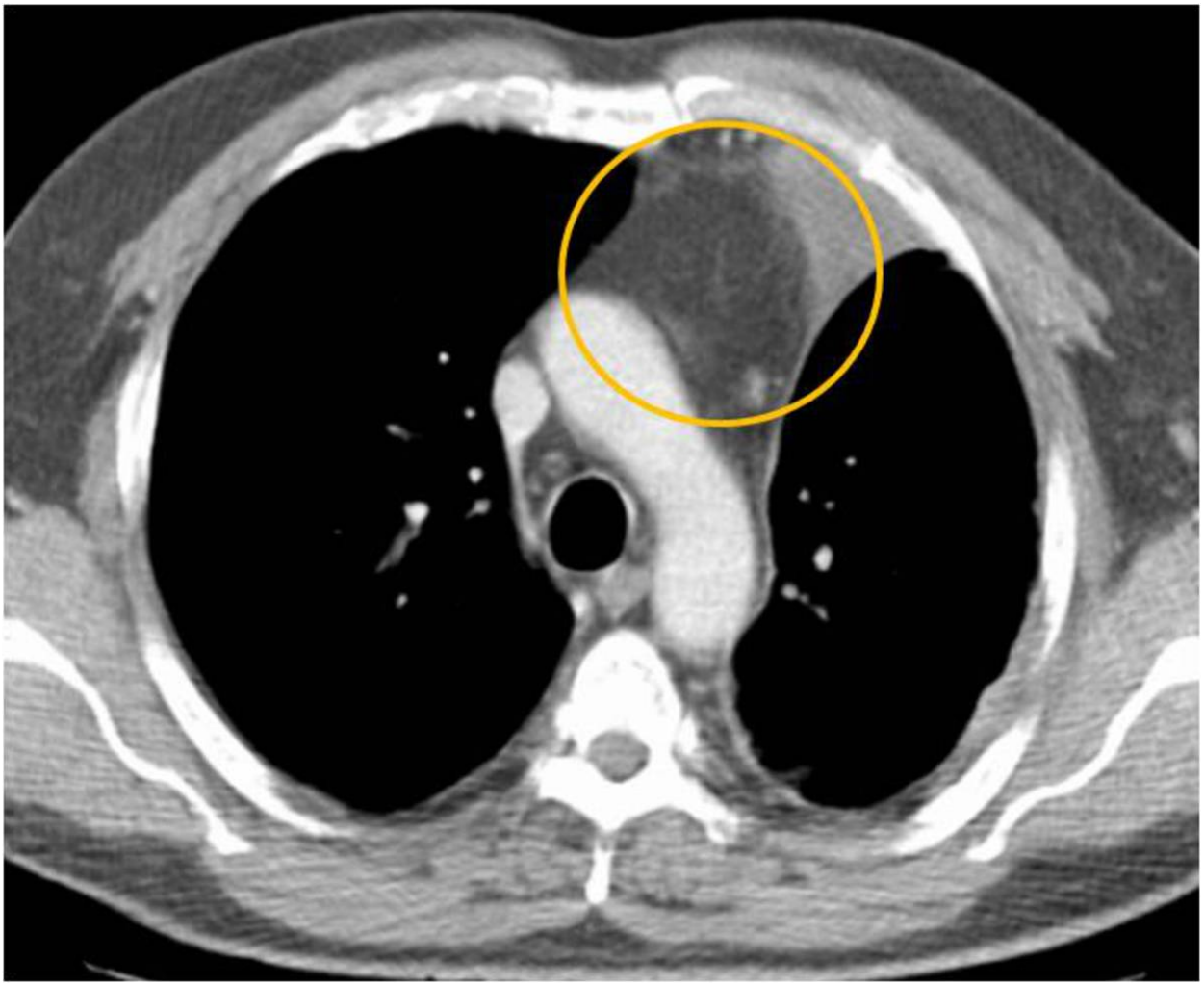

Fig.: Excessive fat accumulation in the anterior mediastinum, in a patient on chronic steroid therapy.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Thymolipoma

Thymolipoma is a rare benign neoplasm of the thymus composed of mature adipose tissue and thymic tissue. Thymolipomas are rare, slow-growing, benign tumors of the thymus thought to represent 2%-9% of all thymic neoplasms.

Although thymolipomas are thymic neoplasms, most of the cases manifests as anterior inferior mediastinal masses on chest radiographs. The anterior inferior mediastinal location of most thymolipomas, the soft and malleable nature of these lesions, and the postulated semisolid consistency of fat at body temperature may contribute to the ability of these tumors to conform to the shape of adjacent mediastinal structures. These features may cause the mass to resemble cardiomegaly on frontal chest radiographs. They also

may cause the lesions to drape along the ipsilateral hemidiaphragm, conforming to its shape and simulating diaphragmatic elevation on lateral radiographs.

Thymolipomas have been described on CT scans as mediastinal masses that contain fat intermingled with small areas of soft-tissue attenuation. Remnants of thymic tissue interspersed with whorls of adipose tissue also have been described. It has been suggested that a thymolipoma can be differentiated from a mediastinal lipoma on the basis of the predominance of fat in the latter. The diagnosis is strongly supported whenever a connection to the anterior superior mediastinum is demonstrated on imaging studies performed in a mass that contains fat and soft tissue or in a predominantly fatty mass.

Teratoma

Mediastinal mature teratoma is a rare, benign, slow-growing neoplasm that usually occurs within or near the thymus gland and accounts for up to 75% of primary germ cell tumors of the mediastinum. Mature teratomas do have the potential in rare circumstances to undergo malignant transformation into a variety of malignancies.

Benign teratomas are well-defined, round, or lobulated masses when seen on a chest radiograph. Up to 26% are calcified, as they often have elements of bone or teeth. CT scanning and MRI are used to assess resectability, and may identify sebaceous elements and fat, supporting the diagnosis.

The most frequent CT manifestation is a heterogeneous mass with soft-tissue, fluid, fat, and calcium attenuation. Teratomas can be distinguished from other mediastinal tumors by their cystic appearance as well as by the frequent inclusion of fluid, fat, calcifications, or teeth.

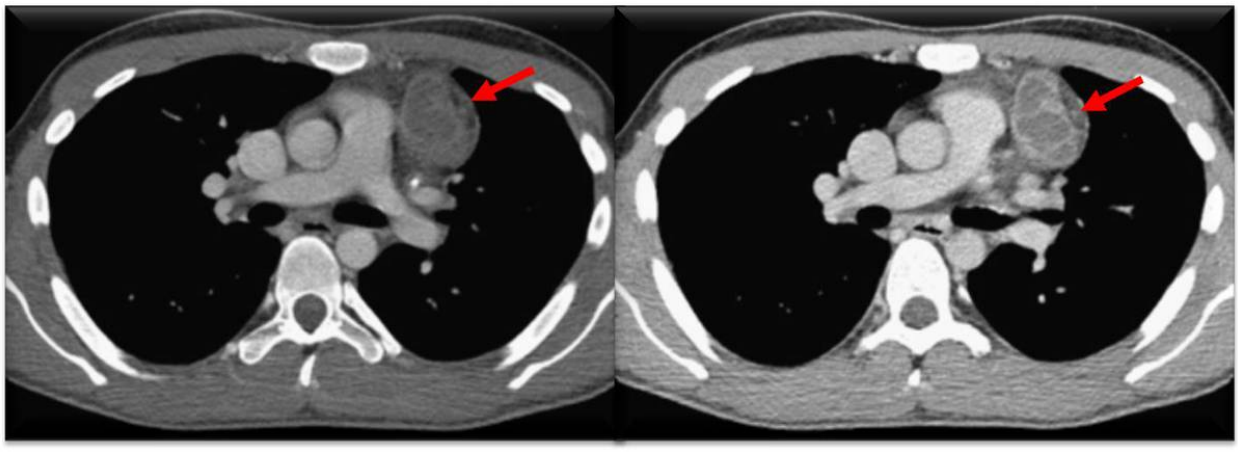

Fig.: Mature cystic teratoma. A contrast-enhanced CT scan shows a multilocular cystic mass in the left anterior mediastinum, with areas of fat attenuation (arrows).

References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Teratocarcinoma

They are typically more nodular or poorly defined than benign teratomas and can mold to and compress surrounding structures. These malignant forms demonstrate fat less often (40% of cases) than do benign teratomas (90%) and are more likely to appear solid.

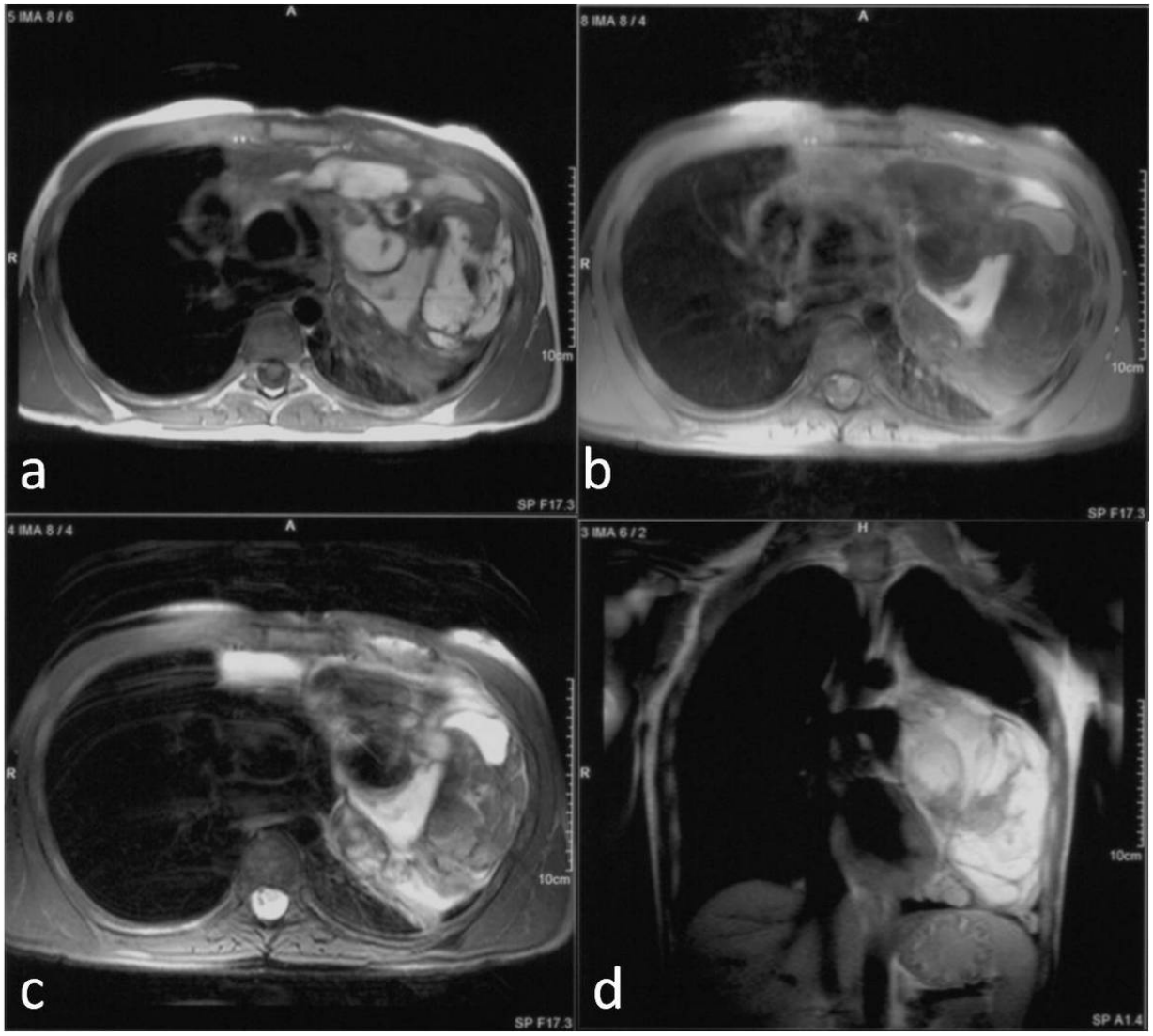

Fig.: Teratocarcinoma. MRI shows heterogeneous mass in the anterior mediastinum, with soft-tissue and fat components.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Lipoblastoma

These fat containing lesions are characterized by predominant intratumoral stranding that can often be identified on CT scans. This tumor can often be differentiated from other mediastinal fat-containing tumors on the basis of the patient's age and clinical history (nearly 75% occur before the age of 12 months). Lipoblastomas lack the fluid or calcific components often seen in teratomas.

3) Cardiac Lesions

Lipoma

Lipomas are the second most common benign cardiac tumor. These tumors are typically found in adult patients but can affect patients of all ages. Many are discovered incidentally, but some can manifest due to symptomatic obstruction to blood flow or compression of the ventricles, especially if they have arisen in the pericardial space.

Cardiac lipomas are largely composed of mature adipocytes. Although there may be entrapped myocytes at the interface of the tumor with the myocardium, the myocytes are not distributed throughout the tumor, as they are in lipomatous hypertrophy of the interatrial septum. A capsule is usually present, although it may be focally absent or attenuated. In contrast to lipomatous hypertrophy of the interatrial septum, cardiac lipomas do not contain brown fat cells.

They may arise in both an epicardial and endocardial location, although the majority appears to be subepicardial, expanding into the pericardial space. (It is hypothesized that many pericardial lipomas originate in the atrioventricular grooves). Multiple lipomas have been reported in patients with congenital heart defects, tuberous sclerosis, and rarely in an otherwise normal heart.

CT and MR imaging are useful for making a tissue-specific diagnosis based on the findings of fat attenuation (Hounsfield measurement less than -50) and signal intensity characteristics of fat. Septations may be visible, but soft-tissue components should not. They do not enhance after contrast material administration.

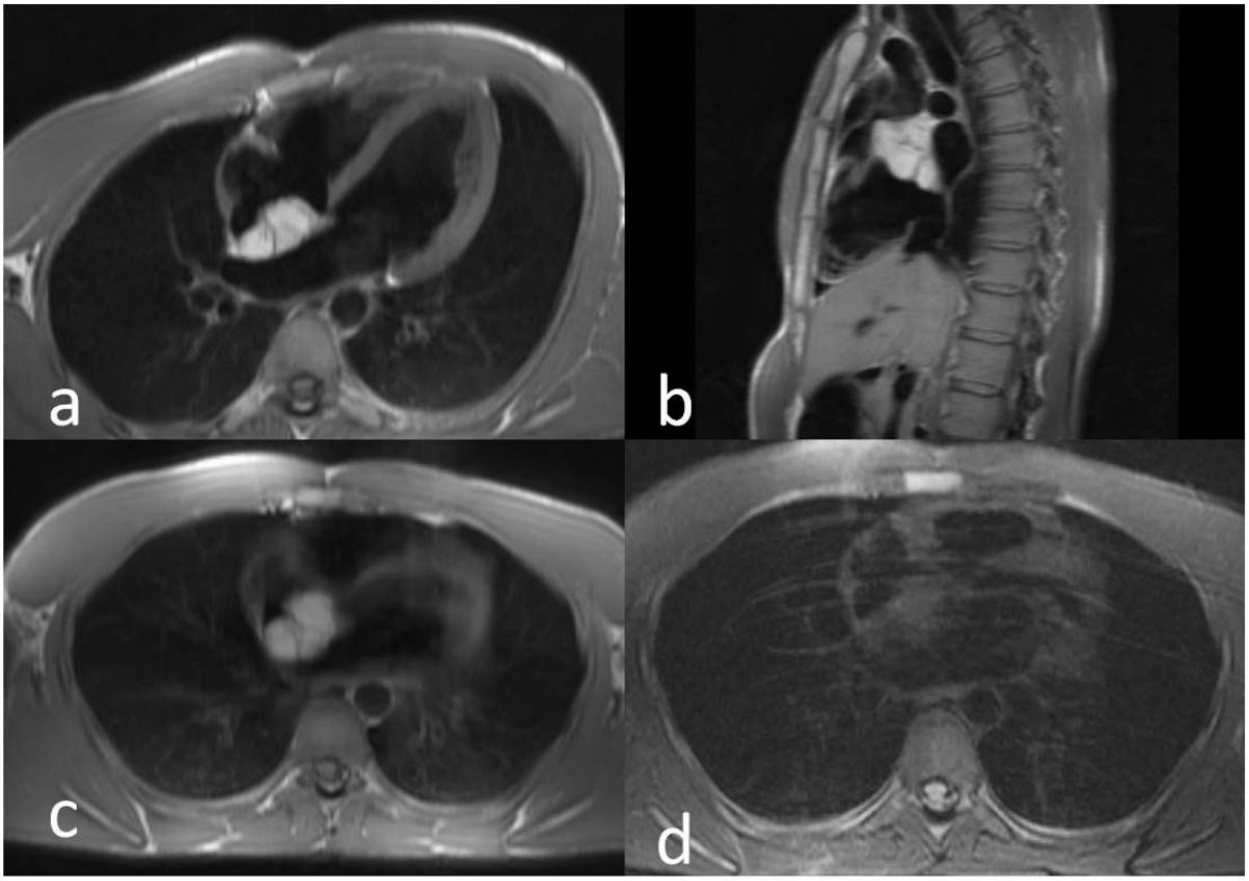

Fig.: Cardiac lipoma. MRI shows a well defined focal mass with a signal intensity characteristic of fat along the interatrial septum. Note the presence of internal septa. Septa not only occur in benign lipomas but also are common in atypical lipomatous tumors and liposarcomas.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Liposarcoma

Extremely rare, but when they occur, they usually originate from the right side of the heart. These tumors may invade locally, infiltrate the heart, or metastasize to the lungs. Local extension is typical for well-differentiated and myxoid liposarcomas. Round cell and pleomorphic tumors show infiltrative growth, early metastasis to the lungs, and frequent local recurrence after surgical resection.

Lipomatous Hypertrophy of the Interatrial Septum

Lipomatous hypertrophy of the interatrial septum is defined as any deposit of fat in the atrial septum exceeding 2 cm in transverse diameter. It is associated with advancing age

and obesity and can result in supraventricular arrhythmias. Microscopically, the absence of a capsule, the presence of cardiac myocytes interspersed amid the fat cells, and the presence of brown fat cells distinguish lipomatous hypertrophy from cardiac lipoma.

Diagnosis is made with CT when a smooth, nonenhancing, well-marginated fat-containing lesion in the interatrial septum is identified. The lesion characteristically takes on a dumbbell shape, with relative sparing of the oval fossa. MR imaging can be used to confirm the composition of the lesion. A large proportion of patients will demonstrate an increase in mediastinal and epicardial fat associated with the lesion.

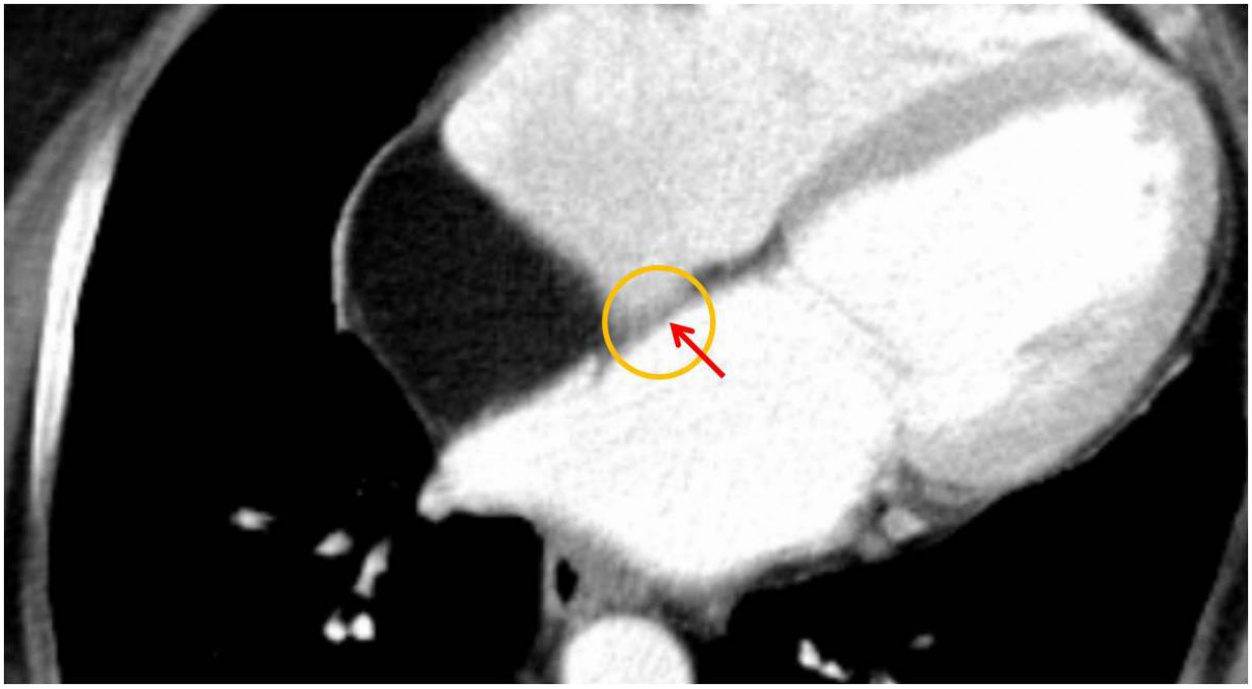

Fig.: Lipomatous hypertrophy of the interatrial septum. CT scan shows a smooth, well-marginated fat-containing lesion in the interatrial septum, with sparing of the oval fossa (circle).
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Arrhythmogenic Right Ventricular Dysplasia

Cardiac abnormality characterized by patchy replacement of the right ventricular myocardium by fatty or fibrous tissue.

The most commonly affected locations include the right ventricular apex, pulmonary infundibulum, and subtricuspid region.

The most common clinical presenting symptom is ventricular arrhythmia. This condition is often first detected in adolescents and young adults. Cine MR imaging is a noninvasive

and repeatable examination that can show fatty or fibrofatty replacement of the right ventricular myocardium as well as global and focal dilatations and wall motion abnormalities. A spin-echo T1- weighted MR image may show increased signal intensity due to fatty infiltration of the right ventricular myocardium.

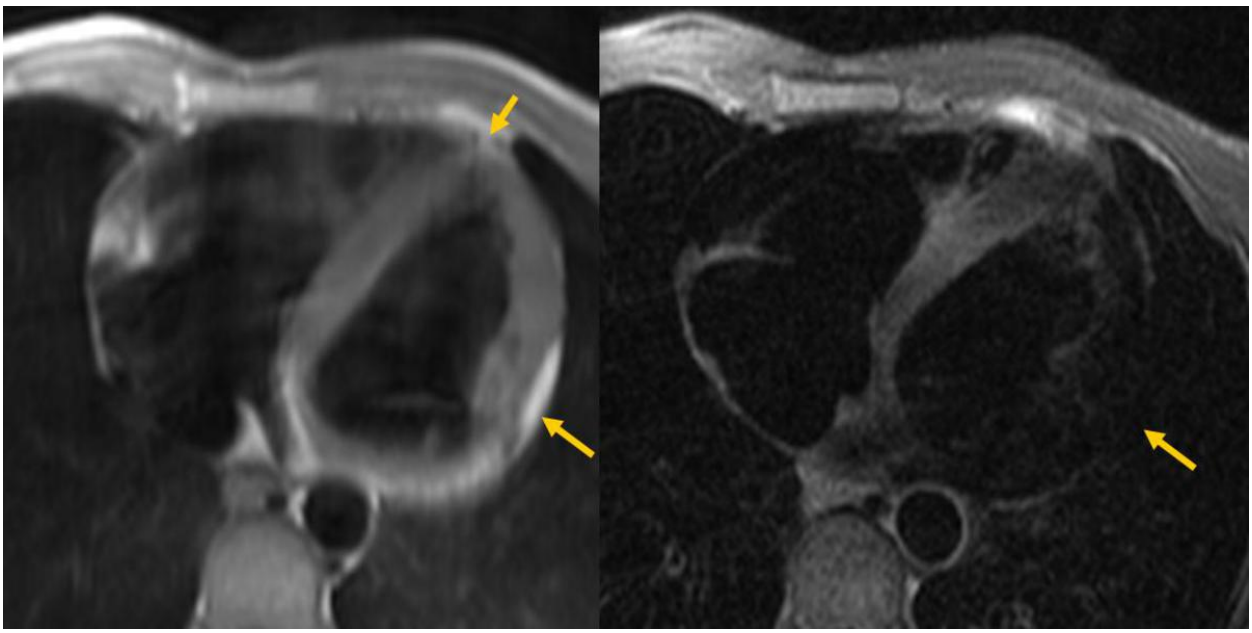

Fig.: Arrhythmogenic right ventricular dysplasia in a 24-year-old woman with recurrent ventricular tachycardia. Axial spin-echo T1- weighted MR and fast spin-echo inversion recovery T2-weighted MR images show replacement of the apical portion and lateral wall of left ventricular myocardium by fatty tissue (arrows). Mostrar ao Donato.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

A more benign form of ARVD, termed *fatty replacement of the right ventricle*, has also been described. Unlike with ARVD, the right ventricular wall is normal in size or thickened and does not show myocyte atrophy or inflammation.

4) Pleural and Extrapleural Lesions

Lipoma

Pleural lipomas are benign soft-tissue neoplasms that originate from the submesothelial layers of parietal pleura and extend into the subpleural, pleural, or extrapleural space. They are soft, encapsulated fatty tumors that demonstrate slow growth. In addition, lipomas can occasionally arise from the diaphragm. Lipomas of diaphragmatic origin are

predominantly found in a posterolateral location and have a 2:1 predilection for the left side.

Pleural and diaphragmatic lipomas appear as soft-tissue lesions on chest radiographs and may become extremely large. At CT, they are homogeneous and demonstrate fat attenuation (approximately -100 HU). If the lesion is near the diaphragm, the differential diagnosis may include hernias and localized eventrations.

Extrapleural fat

Extrapleural fat is fat outside the parietal pleura in the chest wall. It is a component of the loose connective tissue of the endothoracic fascia and is most abundant along the posterolateral aspects of the fourth through eighth ribs bilaterally.

Extrapleural fat is typically bilateral, symmetric, and located along the midlateral chest wall. Definitive diagnosis is made at CT.

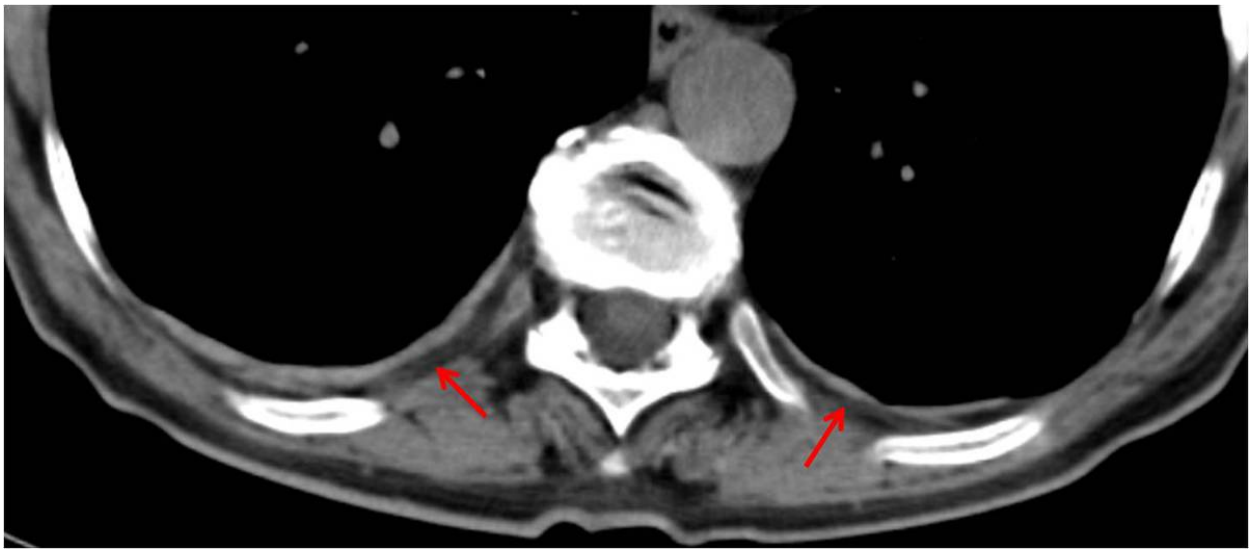

Fig.: The extrapleural fat (arrows) shows homogeneous low attenuation similar to that of the subcutaneous fat. There is thickening of the adjacent pleura.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

5) <u>Diaphragmatic Hernias</u>

Morgagni Hernia

Hernias through the foramen of Morgagni represent 2%-3% of all diaphragmatic hernias. Like Bochdalek hernias, Morgagni hernias are related to disorders of embryologic bowel descent from the chest to the abdomen and subsequent maldevelopment of the diaphragm.

The defect is anterior and retrosternal in location and is usually a right-sided process (90% of cases). The contained abdominal contents may include, in order of decreasing frequency, the omentum, colon, stomach, liver, and small intestine.

Sagittal and coronal reformatted images are often helpful in demonstrating the diaphragmatic defect and identifying the contents of the hernia.

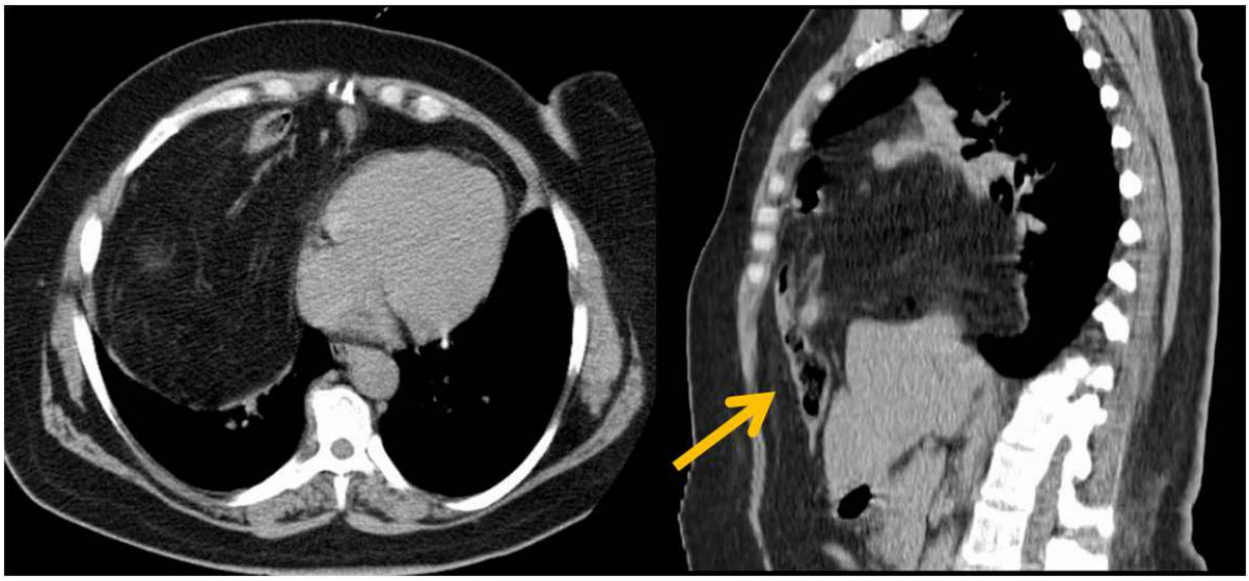

Fig.: Morgagni hernia. CT scan shows a retrosternal hernia that includes the omentum and colon (arrow).
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Bochdalek Hernia

Bochdalek hernias have a prevalence of 3%-6%. They are usually congenital, resulting from disordered development of the diaphragm, but may be acquired as a result of surgery, trauma, or infection. Left-sided hernias are more common (70%-90% of cases), presumably owing to the protective effects of the liver.

It is not uncommon for small, asymptomatic Bochdalek hernias to be found on CT scans obtained for another reason. Bochdalek hernias can also be demonstrated with barium-enhanced radiography.

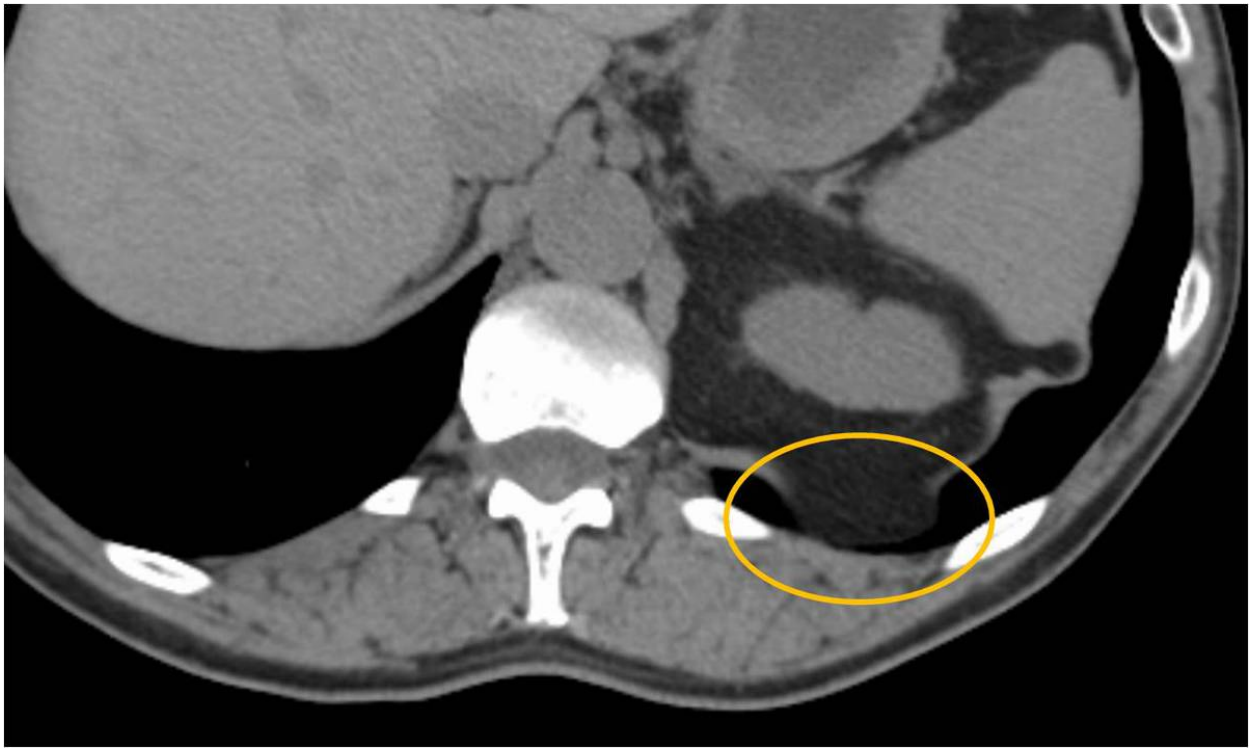

Fig.: Bochdalek hernia. CT scan shows a posterior diaphragmatic defect and fat herniation without organ entrapment.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

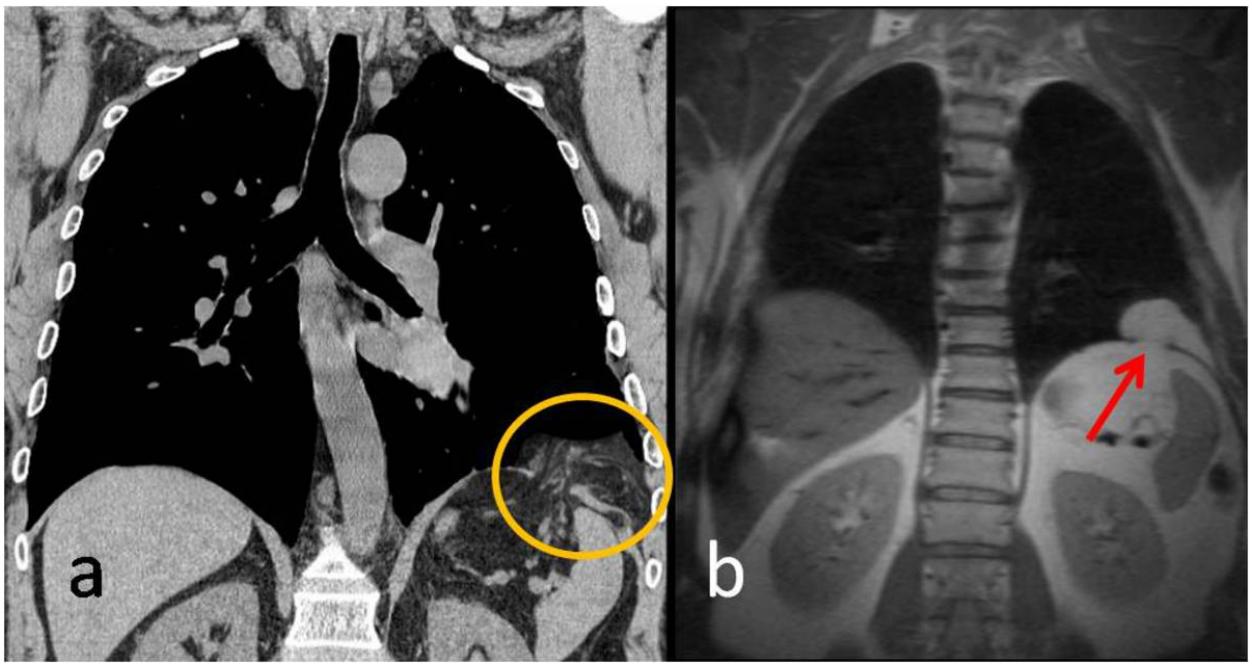

Fig.: Bochdalek hernia. Coronal MIP image from CT scan (a) and coronal HASTE sequence (b) show a posterior diaphragmatic defect and herniation of omental fat and vessels.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Hiatal Hernia

On chest radiographs, a paraesophageal hernia may appear as a soft-tissue-opacity lesion posterior to the heart near the esophageal hiatus.

CT helps verify migration of the stomach cranially through the hiatus.

Fig.: Hiatal hernia. CT scan of the abdomen shows widening of the esophageal hiatus, with cephalic herniation of the stomach (arrow).
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Juxtacaval Fat

Juxtacaval fat is a focal collection of fat that is typically observed medially adjacent to the lumen of the inferior vena cava (IVC), near the hepatic venous confluence. It is contiguous with fat around the subdiaphragmatic esophagus.

At CT, it is usually adjacent to the medial intrahepatic portion of the IVC and often falsely appears to be intracaval in location. Proper evaluation and diagnosis are important to differentiate juxtacaval fat from thrombus or intracaval tumor.

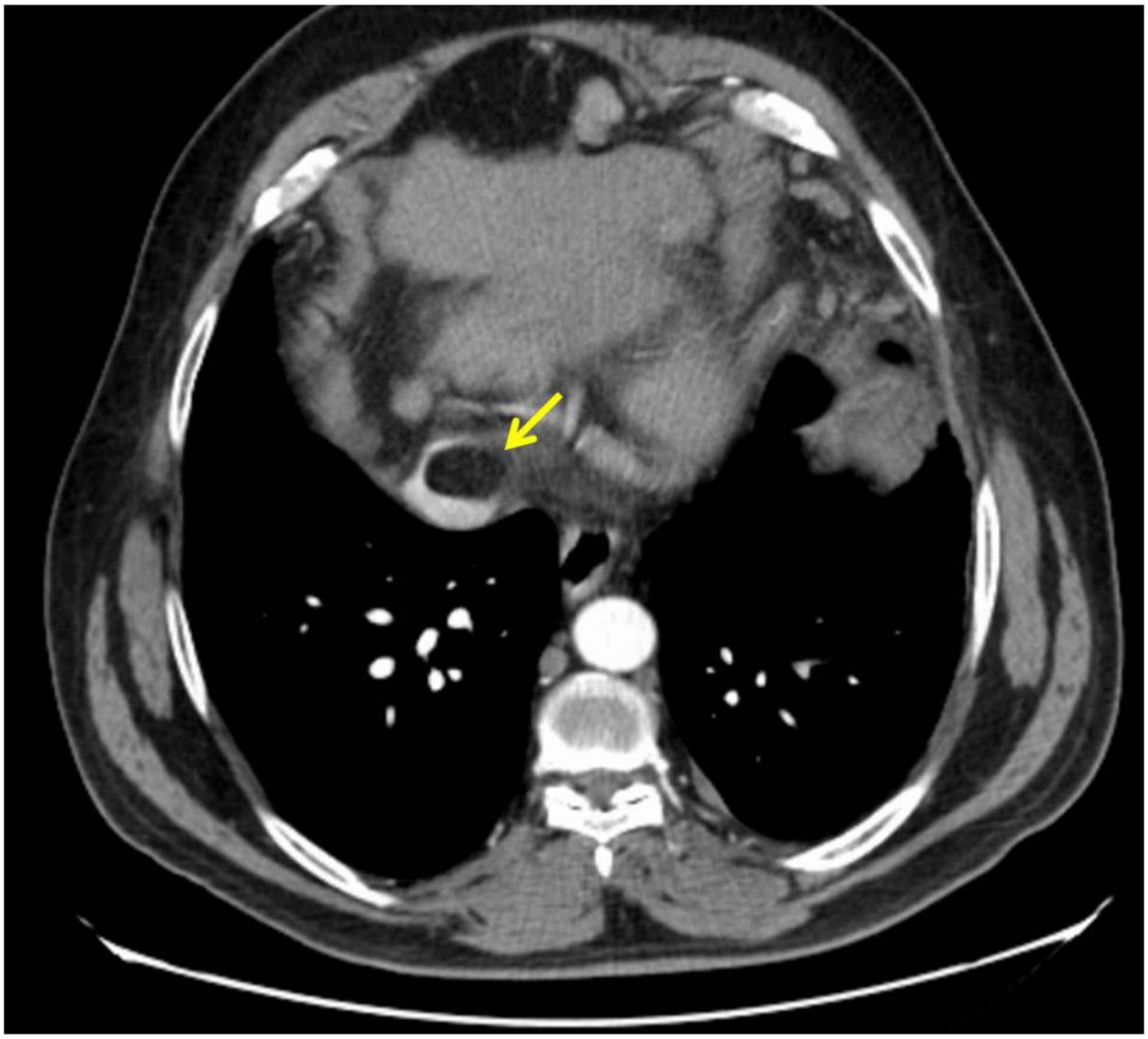

Fig.: Juxtacaval fat. CT scan shows a fat-containing lesion that appears to be within the lumen of the IVC (arrow). Continuity between the juxtacaval fat and paraesophageal fat can often be seen (not shown).
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

6) <u>Chest wall lesions</u>

Lipomas

Most lipomas that originate in the chest wall are deep lipomas, which tend to be larger and less well circumscribed than superficial lesions.

On CT and MR images, lipomas generally appear to be internally homogeneous and do not enhance after intravenous contrast material administration. However, multiple thin septa often are present that appear slightly enhanced on CT scans and have low signal intensity on fat-suppressed T1-weighted MR images.

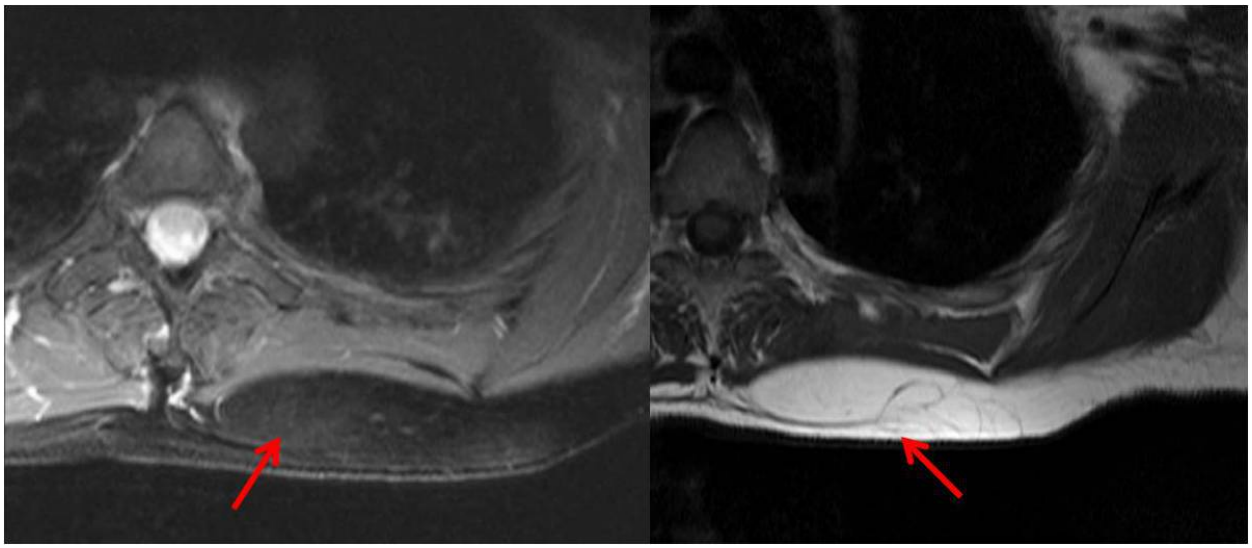

Fig.: Chest wall lipoma. Well-defined mass with the same signal characteristics of fat in the subcutaneous tissue of the back.
References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Hibernoma

Hibernoma is a rare, benign soft tissue tumor of brown fat. The lesion was named for its similarity to the brown adipose tissue encountered in the organs of hibernating animals.

Brown adipose tissue is present in the fetus and gradually is replaced by white adipose tissue with advancing postnatal ages. It persists, however, in varying amounts throughout adult life and may be found in the neck, axilla, mediastinum, and periaortic and perirenal zones.

These masses usually measure 5-10 cm in diameter, although there have been reports of hibernomas reaching 20 cm in size. There is marked hypervascularity, which combines with abundant mitochondria to give hibernomas their brown colour. The marked

hipervascularity of a hibernoma, both microscopically, and angiographically, is typical and in sharp contrast to mature adult fat.

CT shows a well-defined lesion with tissue attenuation intermediate between that of fat and skeletal muscle, usually enhancing after intravenous contrast administration. At MR, lesions are heterogeneous with signal intensity similar, but not identical to that of fat. T1 weighted images show predominantly intermediate-signal mass isointense or slightly hypointense to subcutaneous fat, but hyperintense to normal muscle. On T2 weighted images the mass is isointense to subcutaneous fat and may show multiple foci of high signal intensity. Hibernoma enhances following gadolinium administration using fat-supressed T1-weighted images. The differential diagnosis with liposarcoma is almost impossible and the definite diagnosis is normally made after histopathologic examination.

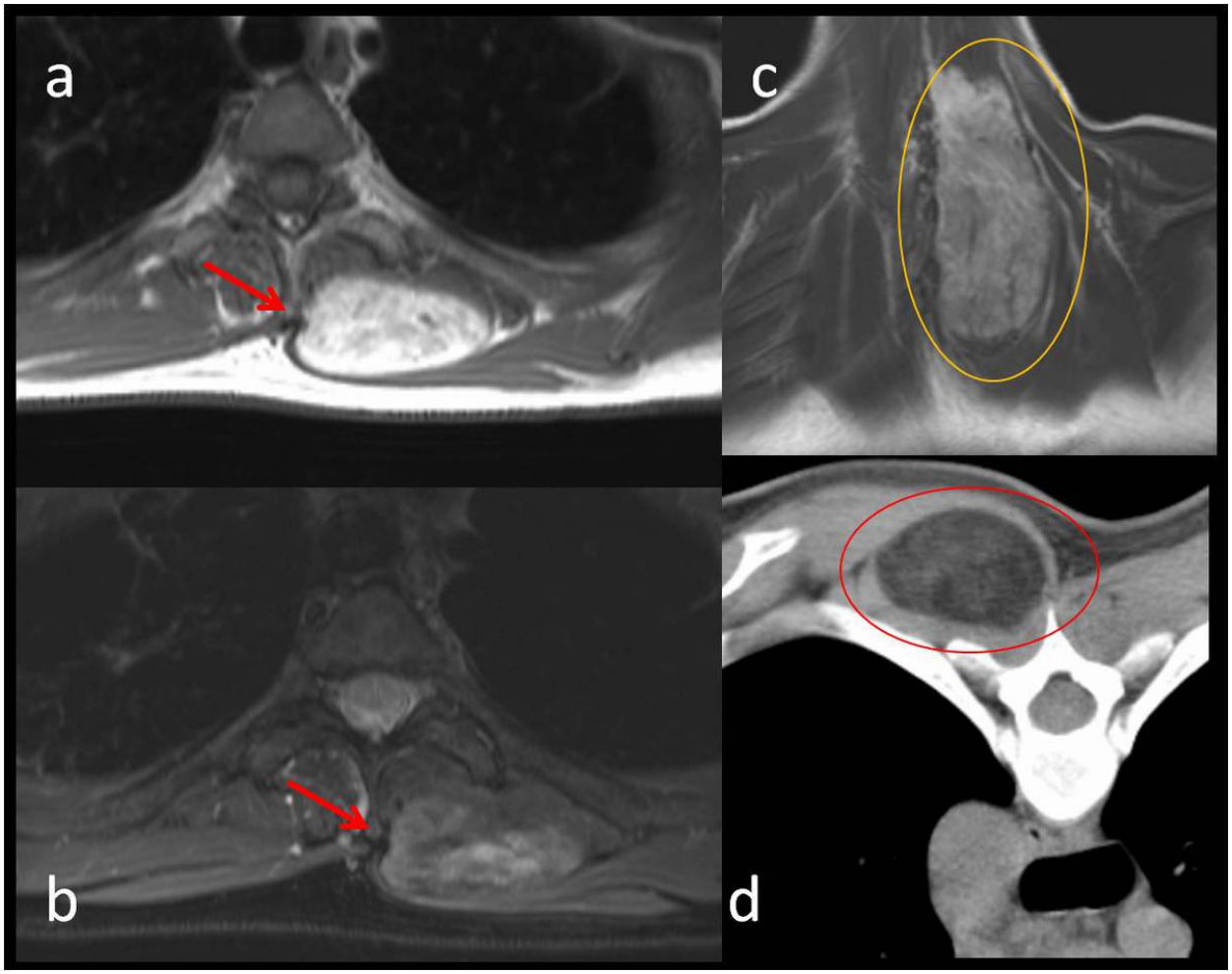

Fig.: MRI reveals a heterogeneous nodule (arrows) with hyperintensity in T1-weighted MR images and loss of signal in T2-FS image. During CT performed for guiding biopsy (note prone position) the fat component in this tumor was also identified, with a slightly increased attenuation.

References: J. F. Costa; Radiology, Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL

Liposarcomas

Liposarcomas constitute 15% of all sarcomas and usually arise as painless masses in the lower extremities or the retroperitoneum. Chest wall origin is uncommon, occurring in about 10% of cases.

The CT appearance and MR imaging findings are closely correlated with these gross anatomic and microscopic findings; well-differentiated tumors have characteristics similar to those of mature fat, whereas poorly differentiated liposarcomas, which are more cellular, have characteristics similar to other solid tumors. The differences seen in these tumors at imaging are reflected in their different prognoses. Round cell liposarcomas often do not contain a large amount of fat and therefore exhibit a nonspecific heterogeneous appearance, with low signal intensity on T1-weighted images and high signal intensity on T2-weighted images.

Conclusion

Narrowing of the differential diagnosis of various fat-containing lesions is possible solely on the basis of their location within the chest. Fat deposits sometimes are a normal variant and do not require treatment.

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