Eur Radiol (2005) 15: 1163–1167
DOI 10.1007/s00330-004-2509-8

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Adrenal gland and adrenal mass calcification

Received: 10 June 2004
Revised: 17 August 2004
Accepted: 19 August 2004

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Abstract With the widespread use of computed tomography (CT), it is not unusual to find calcification within the adrenal glands. There are a variety of adrenal lesions that may calcify, but usually the appearance of the calcification is not specific. However, when the pattern and morphology of the adrenal calcification are combined with the other imaging features and the appropriate clinical history, the correct diagnosis may be suggested.

Keywords Adrenal gland · Adrenal gland · Calcification · Computed tomography (CT)

Introduction

With the widespread use of computed tomography (CT), it is not unusual to find calcification within the adrenal glands. There are a variety of adrenal lesions that may calcify, but usually the appearance of the calcification is not specific. However, when the pattern and morphology of the adrenal calcification are combined with the other imaging features and the appropriate clinical history, the correct diagnosis may be suggested.

Myelolipoma

Adrenal myelolipoma is a rare nonfunctioning benign neoplasm that contains a variable amount of hematopoetic tissue and macroscopic fat, and may also contain calcification [1]. In fact, in some lesions the calcifications predominate with only small areas of fat seen [2]. The diagnosis of this tumor is made by demonstrating macroscopic fat within an adrenal mass at CT or MR imaging (Fig. 1). In general, myelolipomas are discovered incidentally and do not cause symptoms. However, if they acutely hemorrhage or are large enough to exert mass effect on the adjacent organs, they can cause pain. Occasionally, differentiating a myelolipoma from an adrenal teratoma or a well-differentiated liposarcoma arising in the region of the adrenal gland can cause a diagnostic problem.

Adrenal hemorrhage

Adrenal hemorrhage is most commonly secondary to trauma, although additional causes include anticoagulation, sepsis, blood dyscrasias and surgery [3]. Acutely, adrenal hemorrhage is manifested as a well or poorly defined adrenal mass that has increased attenuation (50–60 Hounsfield units on the unenhanced scan) and does not enhance with intravenous contrast. Over time, this may peripherally calcify. In cases in which there is total reabsorbtion of the hematoma, the calcification can take on the shape of a shrunken and densely calcified small adrenal gland. However, if the hematoma does not completely reabsorb, a peripherally calcified nonenhancing pseudocyst remains [4] (Fig. 2). Potentially, an adrenal hemorrhage could become secondarily infected and form an abscess [5]. If not recognized, a chronic adrenal abscess could also peripherally calcify.

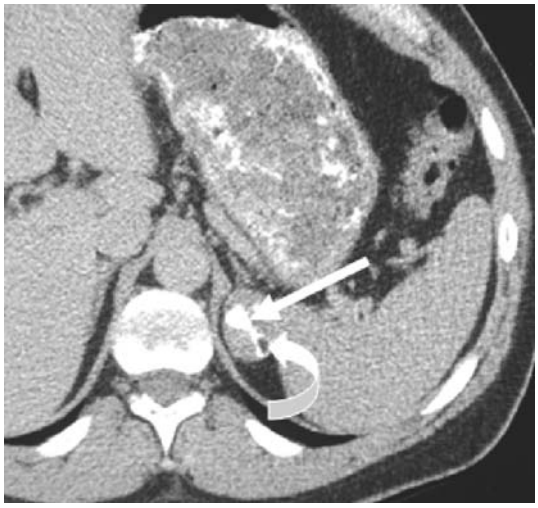

Fig. 1 A 43-year-old male with an adrenal myelolipoma. Unenhanced CT image demonstrates a 2-cm left adrenal mass, which contains calcification (*long arrow*) and a small amount of macroscopic fat (*short arrow*), diagnostic of a myelolipoma

Adrenal cortical carcinoma

Adrenal cortical carcinoma is a rare neoplasm that most commonly occurs in the 4th to 5th decades of life with equal prevalence in men and women. These tumors may contain varying degrees of hemorrhage, necrosis and calcification [3, 6]. When these lesions contain calcification, the pattern is varied and nonspecific. Adrenal cortical carcinomas can grow to be very large and may directly invade adjacent organs, including the kidney, liver, spleen, pancreas and diaphragm. This may make it difficult to determine the exact organ of origin, especially when a normal adrenal gland cannot be identified. However, adrenal cortical carcinoma has a predilection to invade the adrenal veins and grow into the renal vein and IVC. This growth pattern can be used as a clue in diagnosis when encountering a large mass that arises from the adrenal gland.

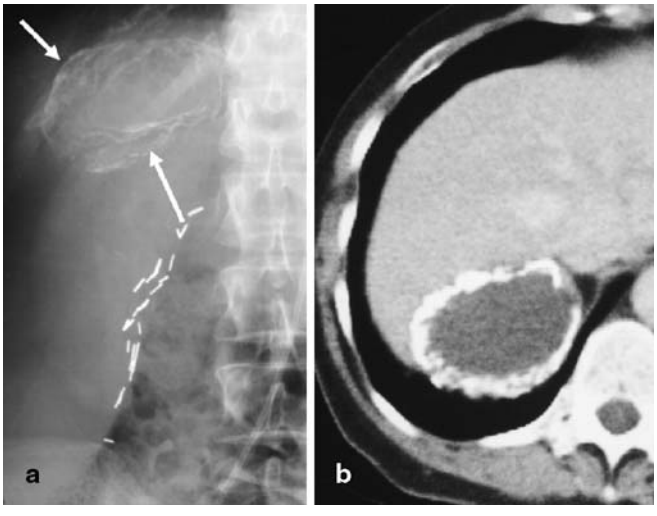

Fig. 2 A 55-year-old female with a history of previous trauma. **a** Abdominal X-ray demonstrates a calcified right supra-renal mass (*arrow*). Surgical clips are secondary to previous gallbladder surgery. **b** Axial contrast-enhanced CT image shows a 5-cm well-defined adrenal mass with thick peripheral calcification. Enhancement could not be demonstrated within the central portion of the mass, which measures 21 Hounsfield units. The mass is unchanged during a 5-year follow-up period and is a presumed adrenal pseudocyst

Neuroblastoma

Neuroblastoma typically occurs in children and usually arises from the adrenal medulla, but may arise anywhere along the sympathetic plexus. The tumor is associated with neurological symptoms and may secrete catecholamines. At CT, they may be heterogeneous secondary to tumor necrosis and hemorrhage and contain calcification in up to 85% of cases (Fig. 3) [7]. Neuroblastomas may invade adjacent organs and spread through the retroperitoneum encasing vessels. Metastases from these tumors most commonly occur in the bones, followed by the liver and skin.

Metastatic disease

The adrenal glands are a frequent site of metastatic disease, particularly from carcinoma of the lung, breast and melanoma. However, occasionally a metastasis to the adrenal gland may represent the only site of systemic spread from a primary neoplasm. Therefore, an assessment of the size, morphology and CT attenuation of an adrenal mass is im-

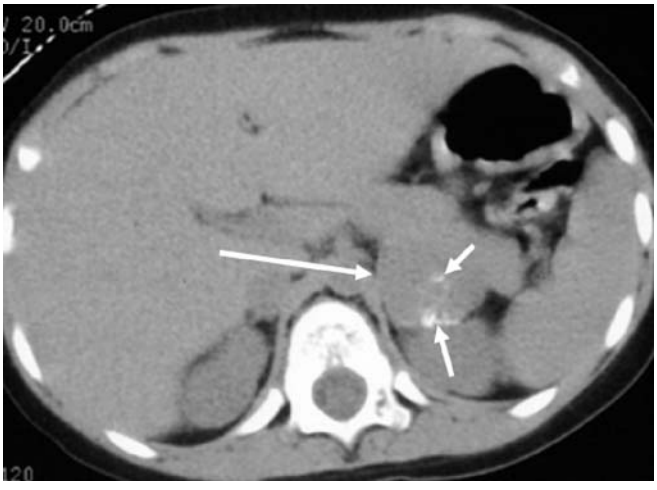

Fig. 3 A 2-year-old female with a neuroblastoma. Unenhanced CT image demonstrates a 2.5-cm soft tissue mass (*long arrow*), which contains a small amount of calcification (*short arrows*) in the left adrenal gland. A neuroblastoma was confirmed pathologically

portant in differentiating adrenal metastases from incidentally detected benign adenomas. Adrenal metastases may have a similar appearance to the primary neoplasm. Therefore, calcified adrenal metastases can occur in patients who have primary neoplasms that calcify, such as mucinous adenocarcinoma, osteosarcoma and papillary thyroid carcinoma (Fig. 4). On the other hand, adenomas rarely calcify [8]. Calcification in adenomas occurs after hemorrhagic degeneration with subsequent fibrosis. These adenomas are typically large, heterogeneous and contain internal soft tissue nodules, and their differentiation from adrenal cortical carcinoma may be impossible [8].

Wolman's disease

Wolman's disease is an uncommon autosomal recessive condition in which foam cells containing cholesterol and triglycerides infiltrate the abdominal organs [9]. Patients typically have abdominal enlargement secondary to hepatosplenomegaly, and the disease is usually fatal by 6 months of age. The adrenal glands are enlarged and contain calcifications, but maintain their normal shape (Fig. 5).

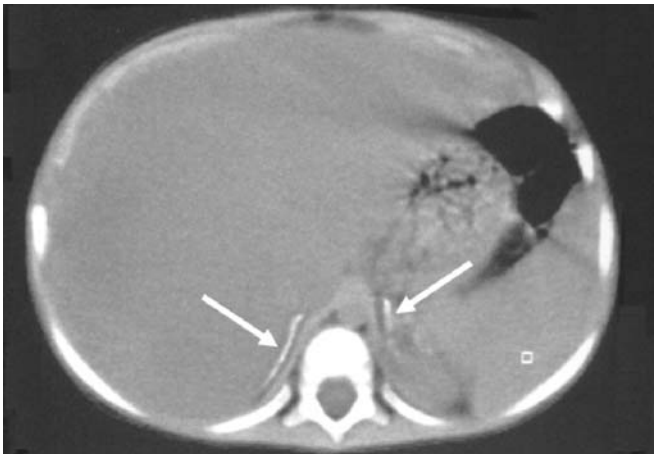

Fig. 5 A 2-month-old male with Wolman's disease. Unenhanced CT image demonstrates an enlarged liver and bilateral adrenal calcification (*arrows*), which conforms to the normal shape of the adrenal glands. (Case courtesy of John Doppman, MD)

Pheochromocytoma

Pheochromocytomas are neoplasms of the adrenal medulla that produce catecholamines and are extra-adrenal, bilateral or malignant 10% of the time. They occur with equal frequency in men and women, and most commonly occur during the 3rd and 4th decades of life. Although most commonly sporadic, pheochromocytomas may be associated with other syndromes including multiple endocrine neoplasia, von Hippel-Lindau disease and neurofibromatosis [7, 10]. Pheochromocytomas may be hypervascular and can show marked enhancement after intravenous contrast. When large, they may contain regions of hemorrhage and necrosis and, although uncommon, they may contain nonspecific calcification (Fig. 6).

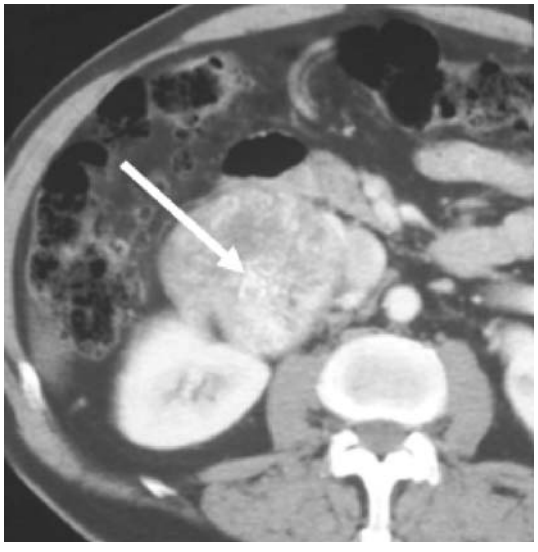

Fig. 4 A 67-year-old male with metastatic mucinous adenocarcinoma of the colon. Contrast-enhanced CT image demonstrates an 8-cm heterogeneous solid mass containing punctate calcifications (*arrow*) in the right adrenal gland. Percutaneous biopsy was performed and metastatic mucinous adenocarcinoma of the colon was diagnosed

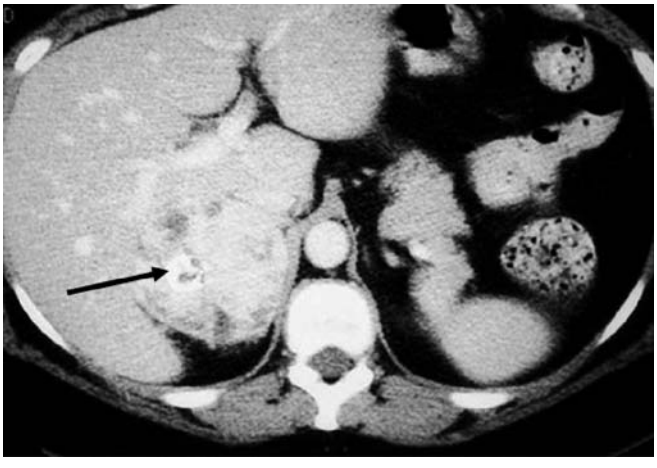

Fig. 6 A 56-year-old female with a pheochromocytoma. Contrast-enhanced CT image demonstrates a 5-cm hypervascular mass containing calcification (*arrow*) in the right adrenal gland. Although its imaging appearance is nonspecific, the patient had a history of "panic attacks" and laboratory evidence to support the diagnosis of pheochromocytoma. At surgical pathology, a pheochromocytoma was diagnosed

Adrenal cysts

Congenital cysts of the adrenal gland are rare and are usually incidentally discovered on cross-sectional imaging. They can be subdivided into endothelial, epithelial, and parasitic cysts [11]. Patients with these lesions are usually asymptomatic unless they are large enough to produce mass effect on adjacent organs or are palpable. At CT, adrenal cysts are fluid attenuation and do not enhance with contrast. They have a thin wall that may contain thin curvilinear calcification.

Granulomatous disease

Tuberculosis and histoplasmosis can involve the adrenal gland and are not distinguishable from each other. During the active inflammatory stage, the adrenal glands may be enlarged, containing low attenuation regions surrounded by a thick irregular wall and possibly some calcification (Fig. 7) [11]. When chronically infected, the adrenal glands may contain increased amounts of calcification, which can be thick and irregular (Fig. 8). Evidence of granulomatous disease elsewhere in the body is helpful in establishing this diagnosis. When chronic granulomatous infection causes adrenal insufficiency, the adrenal glands will be atrophic and often densely calcified.

Hemangioma

Adrenal hemangiomas are rare benign tumors that are usually asymptomatic, but may hemorrhage or cause pain if large enough to exert mass effect on adjacent organs. Characteristically, these lesions may contain phleboliths, and this finding should strongly suggest the proper diagnosis (Fig. 9) [11]. However, if there has been previous hemorrhage, irregular or nodular calcification may also be present.

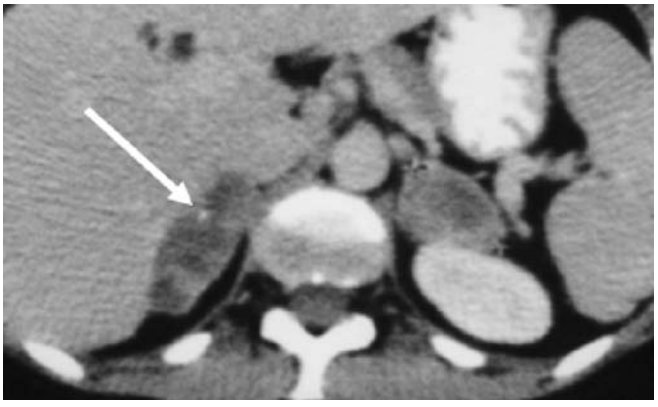

Fig. 7 A 43-year-old female with histoplasmosis of the adrenal glands. Contrast-enhanced CT image demonstrates enlargement of both adrenal glands, which are predominately low attenuating. A punctuate calcification (*arrow*) is present in the right adrenal gland

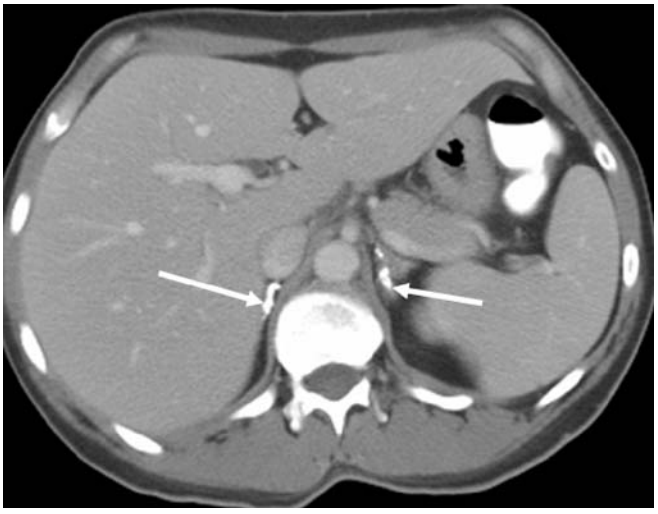

Fig. 8 A 45-year-old male with a history of tuberculous and evidence of granulomatous disease on a chest radiograph. Axial contrast-enhanced CT image demonstrates bilateral moderately thickened adrenal calcifications, presumably secondary to previous tuberculous infection

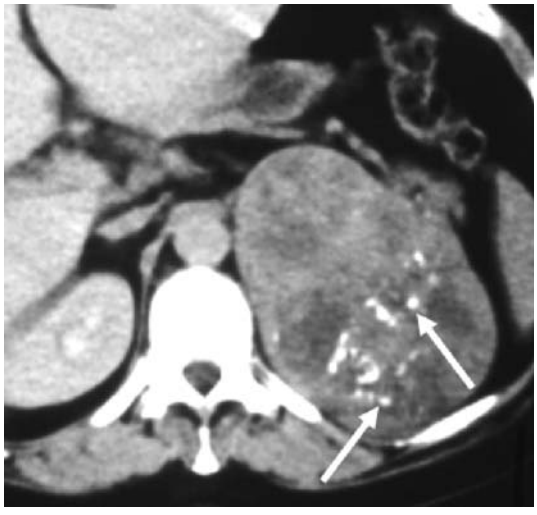

Fig. 9 A 51-year-old female with left-sided pain and an adrenal hemangioma. Contrast-enhanced CT image demonstrates a large heterogeneous left adrenal mass. The mass contains many small round calcifications (*arrows*), consistent with phleboliths. An adrenal hemangioma was diagnosed at surgical pathology

Adrenal mature teratoma

Mature teratomas are germ cell neoplasms composed of tissues derived from the embryonic germ cell layers and originate from cells that fail to migrate to their normal gonadal location [12]. Rarely, they may arise in the adrenal gland. They may appear as a heterogeneous mass, which

may contain fluid, macroscopic fat and calcification. They may be difficult to differentiate from a myelolipoma; however, a fat-fluid level is a characteristic imaging feature of an adrenal teratoma [12].

Conclusion

Calcification in the adrenal gland is not uncommon. Although the calcifications themselves rarely dictate the diagnosis, the morphology of the calcification can suggest the correct diagnosis, such as in hemangioma (in which the calcifications represent phleboliths) and pseudocyst/congenital cyst (in which the calcification is typically peripheral and associated with a nonenhancing mass). Sometimes, the associated imaging findings suggest the correct diagnosis. The identification of macroscopic fat within a calcified adrenal mass narrows the differential diagnosis to myelolipoma and teratoma. Although their differentiation may be difficult, the presence of a fat-fluid level is suggestive of teratoma. The presence of tumor thrombus within the inferior vena cava suggests adrenal cortical carcinoma. In some cases, the clinical history along with the adrenal findings will be diagnostic. A calcified adrenal mass in a child represents a neuroblastoma, while calcification in the adrenal glands that are enlarged but maintain their normal shape in an infant (less than 6 months old) suggests Wolman's disease. In a patient with symptoms related to or laboratory evidence of excess catecholamines, a pheochromocytoma should be suspected. Finally, a history of a primary malignancy that may calcify or a history of previous tuberculosis or histoplasmosis suggests metastatic or granulomatous disease, respectively.

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