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# Calcified Adrenal Masses

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**Abstract.** We reviewed 106 cases of adrenal masses of all types in all age groups. Thirty-three contained calcium visible on radiographs, sonography, or computed tomography (CT). Neuroblastoma was the most common calcified adrenal mass (10 cases), and occurred only in children. Adrenal cyst (6 cases) was the most common calcified adrenal mass in adults. Other calcified adrenal masses included 5 cortical adenomas, 4 adrenal carcinomas, 3 cases of adrenal hemorrhage, 2 adrenal metastases, 2 pheochromocytomas, and 1 histoplasmoma. Calcification within an adrenal mass is therefore nonspecific. All the adrenal cysts had a characteristic radiographic pattern, showing only peripheral curvilinear calcification. The presence and pattern of calcium in an adrenal mass must be correlated with other imaging features (*e.g.*, size, homogeneity, enhancement pattern, margination) to allow correct differential diagnosis. This can best be done by CT.

**Key words:** Adrenal gland, calcification — CT, adrenal gland — Neoplasms, adrenal gland.

Detection of adrenal masses has become much easier with the widespread availability of high-resolution computed tomography (CT) and ultrasound equipment. An extensive literature describes the normal appearance of the adrenal glands and the characteristic CT and ultrasound features of the many masses that can occur in the adrenal glands. There have been numerous descriptions of calcified adrenal masses due to a variety of causes, yet no recent publication has investigated the diagnostic implications of the presence of calcium in an adrenal mass. It has been suggested that calcification in a suprarenal location should be considered suspicious for adrenal carcinoma [1]. However, while calcification has been frequently noted in adrenal carcinoma [1–4], it has also been reported in cortical adenoma [4, 5], neuroblastoma [6, 7], adrenal cyst [8, 9], pheochromocytoma [2, 10–12], and inflammatory disease [13–15]. From these sporadic reports it is very difficult to discern the relative prevalence of different causes of adrenal calcification.

This study was designed to investigate the prevalence of calcium in adrenal masses, to see which processes most frequently presented as calcified adrenal masses, and to determine if there are radiographic patterns that indicate a specific cause of a calcified adrenal mass.

## Materials and Methods

All adrenal masses with definite diagnosis in which radiographic studies (plain radiographs, ultrasound, CT, or angiography) were available were reviewed retrospectively. Cases were collected by reviewing medical records from 1980 to 1985 and radiology teaching files at the University of Alabama at Birmingham and State University of New York Health Sciences Center at Syracuse. Diagnosis was based on the pathologic examination of a specimen in 77% (82/106). In the remainder, diagnosis was based on radiographic and biochemical findings and clinical follow-up consistent with a specific diagnosis (*e.g.*, neonatal adrenal hemorrhage, nonhyperfunctioning adenoma, etc.). Cases without definite diagnosis or follow-up were excluded. The cases were reviewed with respect to the following radiographic and imaging charac-

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**Table 1.** Calcified adrenal masses

| Cause | No. calcified | No. not calcified | % of series | % Calcified |
|---|---|---|---|---|
| Cortical adenoma | 5 | 21 functional<br>9 nonhyperfunctional | 15 | 14 |
| Adrenal carcinoma | 4 | 6 | 12 | 40 |
| Metastasis | 2 | 10 | 6 | 16 |
| Pheochromocytoma | 2 | 19 | 6 | 9 |
| Neuroblastoma | 10 | 2 | 30 | 85 |
| Adrenal cyst | 6 | 2 | 18 | 75 |
| Histoplasmosis | 1 | 1 | 3 | 50 |
| Adrenal hemorrhage | 3 | 3 | 9 | 50 |
| Total | 33 | 73 | | |

teristics: presence or absence of calcium, location and pattern of calcification, size of the mass, homogeneity and margination of the mass on CT or ultrasound, and enhancement pattern (on postcontrast CT). Relative prevalence of calcification was determined by comparison of calcified masses to the total number of cases of the same cause.

## Results

Of the 106 cases available to review, 33 had calcium visible on plain radiography, CT, or ultrasound. Table 1 lists the causes of the cases of calcified adrenal masses.

### *Cortical Adenoma*

Five cortical adenomas contained calcium (Fig. 1). Of the 4 surgically proven cases, 3 presented with hypercortisolism and 1 with virilization. One patient had no endocrine disorder and is presumed to have a nonhyperfunctioning adenoma since follow-up at 1 year shows no change. In all 5 cases the calcium was centrally located within the mass. The masses averaged 4 cm in diameter and all were smooth, round, well-marginated homogeneous masses with minimal enhancement on CT. Twenty-one functional and 9 nonhyperfunctioning adenomas were noncalcified; thus calcified adenoma represented 15% of all calcified adrenal masses and 14% of all adenomas contained calcium.

### *Adrenal Carcinoma*

Four of the 10 adrenal carcinomas reviewed contained calcium (Fig. 2). All cases were surgically proven. One patient had hypercortisolism; the remaining 3 had no endocrine disorder. In all cases the calcium was located within a soft tissue mass in the adrenal. The masses averaged 15 cm in diameter. Sonography done in 2 showed solid inhomogeneous masses. All 4 showed inhomogeneous density and irregular postcontrast enhancement on CT. Three of the 4 showed local invasion and/or distant metastases. Thus 40% of the adrenal carcinomas in this series were calcified and adrenal carcinoma represented 12% of all calcified adrenal masses in this series.

### *Metastases*

Only 2 of the 12 cases of adrenal masses due to metastatic deposits contained calcium (Fig. 3). In both cases, calcified adrenal masses were found in association with calcified metastases elsewhere. The adrenal masses in these 2 patients were not biopsied but fluctuated in size in concert with other biopsy-proven metastatic deposits. One patient had mucinous adenocarcinoma of the colon and the other had seminoma. Metastases represented 6% of all the calcified adrenal masses.

### *Pheochromocytoma*

Twenty-one adrenal pheochromocytomas were available to review; only 2 contained calcium visible on plain radiographs. Neither had CT. The calcium was seen as stippled density within a suprarenal mass. In both cases the correct diagnosis was suggested by the presence of an adrenal mass and biochemical evidence of excess catecholamine secretion.

### *Neuroblastoma*

Ten cases of neuroblastoma out of a total of 12 contained calcium visible on plain radiographs and/or sonography or CT. In all cases calcium lay within a soft tissue adrenal mass (Fig. 4). The masses frequently were inhomogeneous on CT and showed local or distant extension in several cases. Thus neuroblastoma was the most common cause of a calcified adrenal mass (30%); 83% of neuroblastoma had calcium visible by CT. The average age of patients at presentation was 2 years.

### *Adrenal Cyst*

Eight adrenal cysts were reviewed. Calcium was present in 6 (Fig. 5). In all 6 cases the calcium was limited to the periphery. In 4, the calcification was thickest at the inferior aspect of the cyst. A CT scan was done in 4 cases of adrenal cyst; in each case the cyst did not enhance but the contents had soft tissue

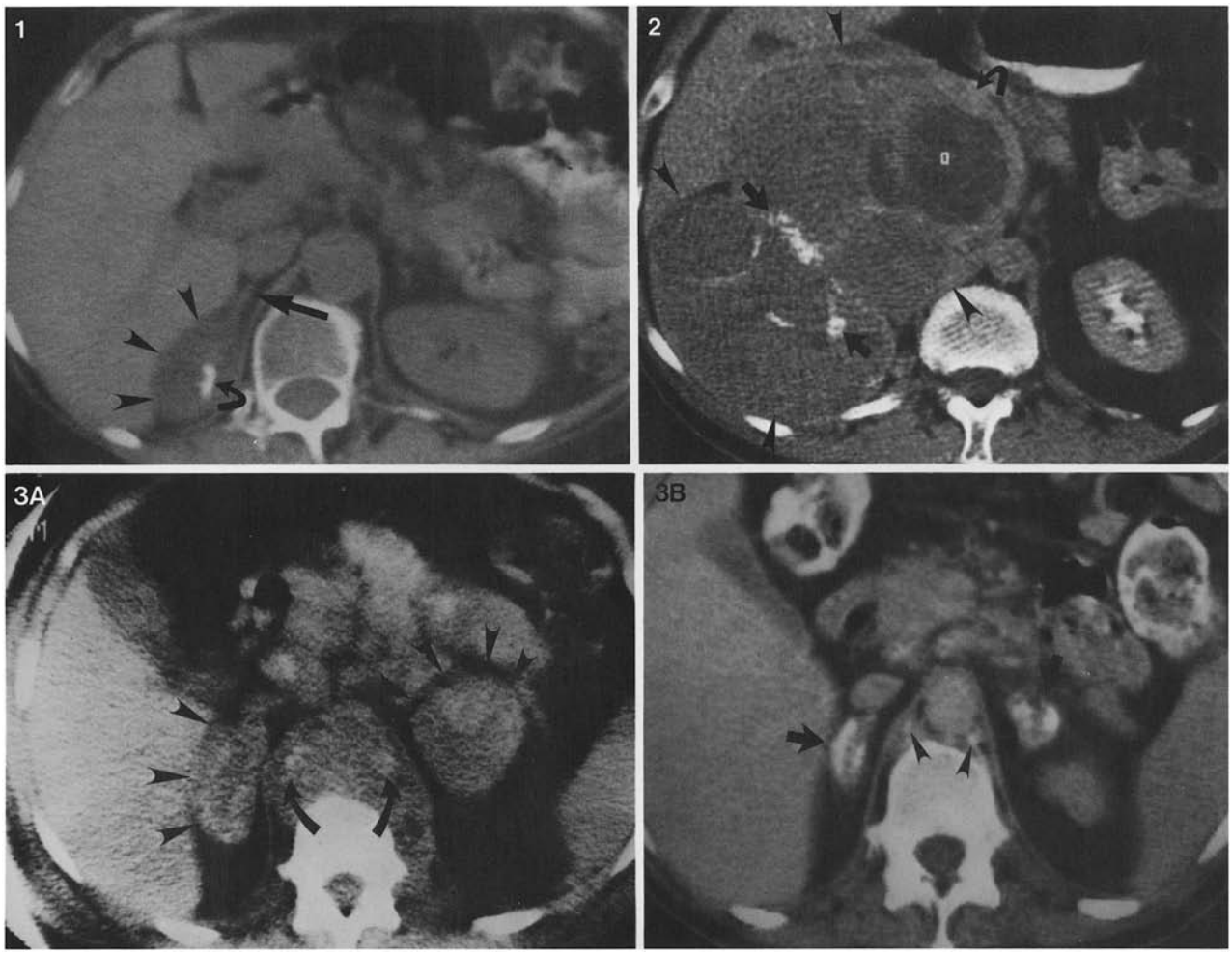


**Fig. 1.** Plain radiographs in a 54-year-old woman with Cushing's syndrome showed right suprarenal calcification. The CT scan reveals the calcification (*curved arrow*) lies within a 3 × 4 cm mass (*arrowheads*) arising from the right adrenal (*arrow*). The left adrenal is normal. A cortical adenoma was resected.

**Fig. 2.** A 50-year-old man with vague abdominal pain had a right upper quadrant mass on physical examination. Plain radiograph showed right upper quadrant calcification. He had no endocrine disorder. A huge inhomogeneous suprarenal mass (*arrowheads*) containing calcification (*arrows*) is shown on CT. The vena cava (*curved arrow*) is displaced anteromedially.

**Fig. 3.** A 44-year-old man presented with acute renal failure and palpable abdominal masses. The CT scan showed extensive retroperitoneal adenopathy with calcification. Pelvic adenopathy was also present. **A** Both adrenals are enlarged (*arrowheads*) with faint calcification. Also note retrocrural adenopathy with calcification (*curved arrows*). Pelvic node biopsy revealed seminoma. **B** Three and one-half months later, after chemotherapy, the metastases have regressed. The adrenal calcifications (*arrows*) are denser. Residual retrocrural calcification persists (*arrowheads*).

density in 1. The cysts averaged 5 cm in diameter. Adrenal cyst was the second most common cause of a calcified adrenal mass (18%). Seventy-five percent of the adrenal cysts available to review were calcified.

### *Adrenal Hemorrhage*

Three patients with adrenal hemorrhage developed a calcified adrenal mass. All had neonatal adrenal hemorrhage secondary to traumatic delivery. Calcification was first seen at 2, 3, and 6 months of age (Fig. 6). None of these children developed any endocrine dysfunction. Three cases of adrenal hemorrhage in adults were reviewed. Although adrenal masses were present, no calcification was seen at the time of presentation. No follow-up scans were done.

### *Inflammatory Disease*

Two cases of adrenal mass were due to histoplasmosis. In 1, small flecks of calcium consistent with

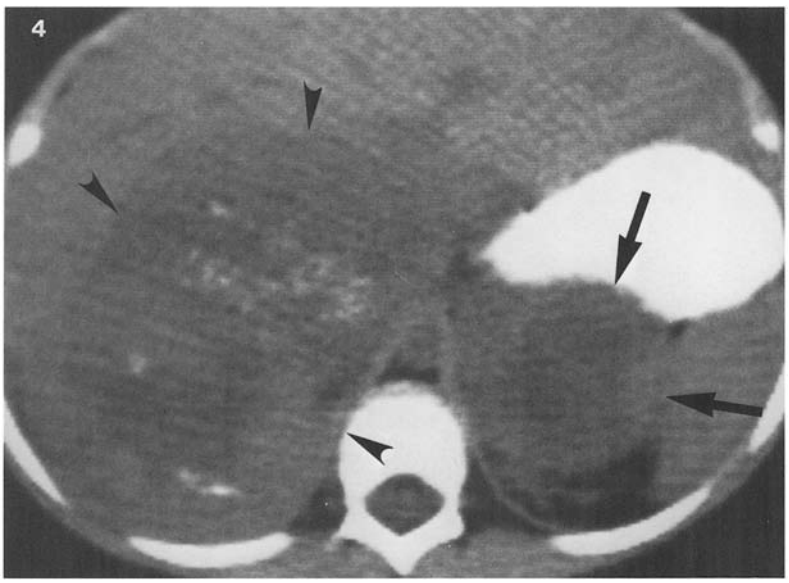


**Fig. 4.** A 4-year-old girl presented with fever, weight loss, and anemia. Physical examination revealed a right upper quadrant mass. Plain radiographs showed no calcification. Unenhanced CT shows large right suprarenal mass (*arrowheads*) with calcification and a smaller left suprarenal mass without calcification (*arrows*). Neuroblastoma was proven by biopsy.

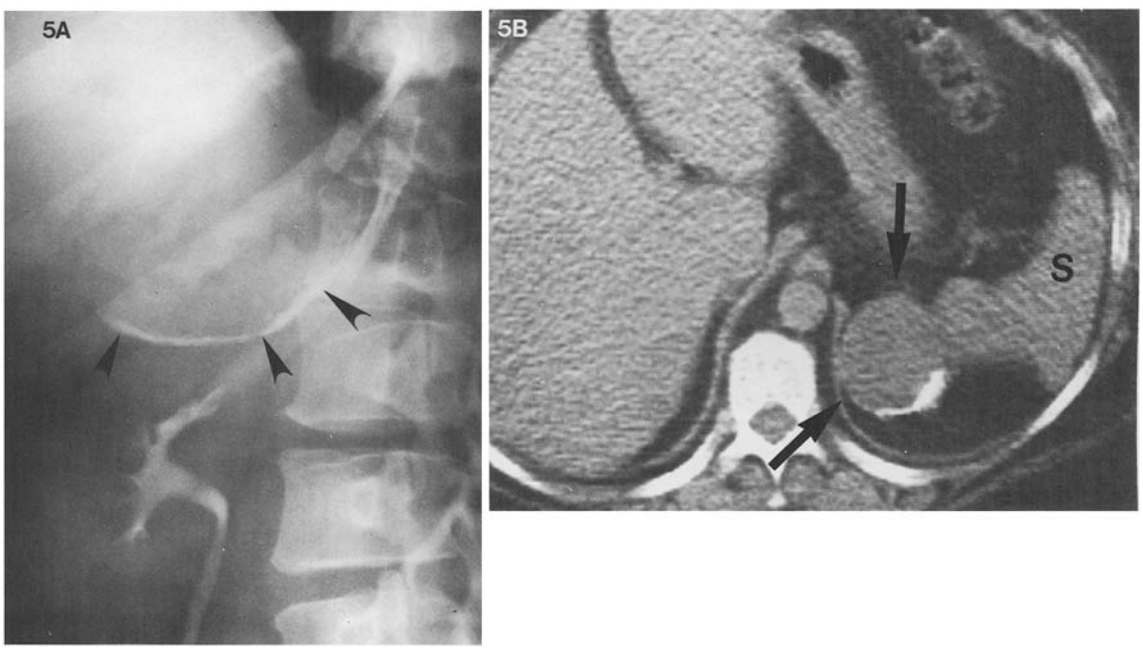


**Fig. 5.** **A** In a middle-aged woman with vague complaints of abdominal pain the urogram shows a suprarenal mass with calcification in the inferior wall (*arrowheads*). No endocrine disorder was present. Surgery revealed an adrenal cyst. **B** A 57-year-old woman had CT after resection of rectal carcinoma. The left adrenal contains a mass (*arrows*) with peripheral calcification. Note the density of the mass is the same as that of the spleen (*S*) on this unenhanced scan. The adrenal mass did not enhance after contrast. Exploratory surgery revealed metastases in the liver and an adrenal cyst.

calcified granulomas were present within a small mass. The patient had histoplasmosis that was inactive at the time of examination by CT. Granulomas were also present in the spleen and liver.

### *Adrenal Calcification without Mass*

The design of this study was such that only patients with adrenal masses were systematically reviewed. However during review of this material, several cases of adrenal calcification without a mass were discovered serendipitously.

Four patients with suprarenal calcification on plain radiographs had CT as part of their work-up of suspected adrenal disease. Two were hypertensive: 1 had essential hypertension, the other had an aldosteronoma in the contralateral adrenal. None of these 4 patients had an endocrine disorder caused by the calcified adrenal. In all 4 CT showed adrenal calcification but no soft tissue mass (Fig. 7). These

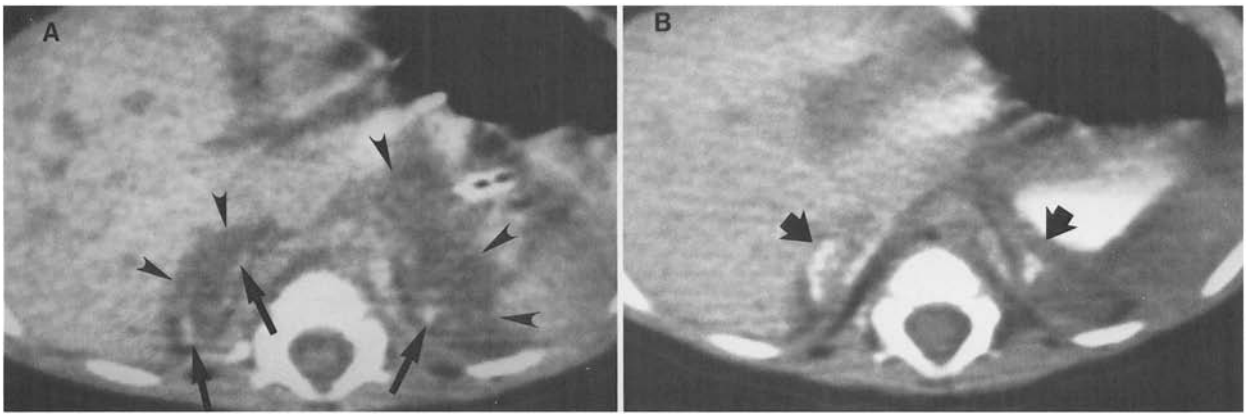


**Fig. 6.** A 7-week-old girl had failure to thrive after a traumatic delivery. Sonogram revealed a suprarenal mass. **A** On CT, both adrenals (*arrowheads*) are enlarged with faint calcification (*arrows*). The findings are consistent with neonatal adrenal hemorrhage. **B** The patient did well clinically and had no endocrine disorder. The CT scan 1 month later shows shrinkage of the adrenals with more dense calcification (*arrows*).

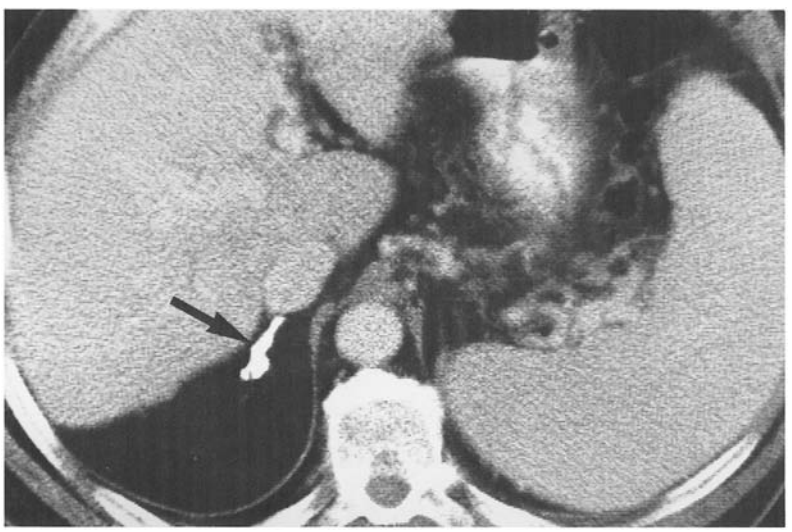

**Fig. 7.** The CT scan from a 64-year-old man evaluated for thrombocytopenia. Plain radiographs had shown calcification in the right upper quadrant. The CT reveals dense calcification of the right adrenal (*arrow*) but no soft tissue mass. No endocrine disorder was present; the patient has idiopathic adrenal calcification. This case demonstrates the ability of CT to exclude an adrenal mass when suprarenal calcification is present.

cases of adrenal calcification are probably the result of remote adrenal hemorrhage.

## Discussion

Several conclusions can be drawn from this study. The mere presence of calcium within an adrenal mass is nonspecific: it neither indicates a specific cause nor excludes any cause. Some fraction of all the types of adrenal masses in this review were calcified. The presence of calcium in an adrenal mass is not an indicator of malignancy: 48% of the calcified adrenal masses were malignant and 52% benign. However, when the pattern of calcification is combined with the other imaging and clinical features, diagnosis is usually clearly evident. Adenomas are small, round, well-circumscribed lesions whether calcified or not; carcinoma and neuroblastoma are large inhomogenous masses, often with metastases or local invasion, whether calcified or not.

One pattern of calcification was characteristic: in all cases of calcified adrenal cysts, the calcium was only present in the periphery, often densest at the base. On CT, the contents of the cyst were of variable density, and the wall was thick, but the mass did not enhance after contrast. Such so-called cysts are usually pseudocysts due to prior hemorrhage. This hemorrhage probably accounts for the increased density of the cyst contents in such cases. If an adrenal mass has the characteristics described above, confident diagnosis of adrenal cyst can be made as long as no endocrine disorder is present. Rare cases of cystic pheochromocytoma or neuro-

blastoma have been reported [16]. However, biochemical evidence of excess catecholamine secretion should indicate the correct diagnosis.

The relative prevalence of causes of calcified adrenal masses is difficult to assess. While this is the largest series of calcified adrenal masses recently reported, the numbers due to any single cause are small. Other institutions with a different patient population may have different relative prevalence of certain causes. In this series, neuroblastoma was the most common calcified adrenal mass. All, however, occurred in children (age range: 1–8 years). Neonatal adrenal hemorrhage was the next most common calcified adrenal mass in children. Other pediatric cases included 2 adenomas (3 months, 2 years of age), adrenal carcinoma (15 years old), and pheochromocytoma (17 years old). All 6 cases of calcified adrenal cyst presented in adults, making this the most common cause of calcified adrenal mass in patients over age 18. Three calcified cortical adenomas and 3 calcified adrenal carcinomas presented in adulthood, these being the next most common causes in this age group. Two cases of metastases, 1 of pheochromocytoma, and 1 of histoplasmosis occurred in adults. While nearly any adrenal mass can calcify, neuroblastoma (83%) and adrenal cyst (75%) seem most likely to do so, while adrenal carcinoma (40%) calcifies frequently. Adenoma (14%) and pheochromocytoma (9%) calcify only uncommonly.

While not represented in this study, we have seen adrenal calcification due to Wolman's disease and teratoma. Myelolipomas also may calcify [17].

In this series, a surprisingly large fraction (nearly one-third) of all adrenal masses contained calcium. This may be partially due to the sensitivity of CT to calcium; however, it is probably largely due to the patient population. Nearly one-third of all the patients with adrenal mass had neuroblastoma, adrenal cyst, or adrenal carcinoma, which are the types of masses most likely to calcify. Metastases accounted for only 11% of the total cases. However, at our institution metastases to the adrenals are not usually coded as adrenal disease, and thus a selection bias is introduced since these cases are not easily retrievable. Also, unproven cases were excluded.

While this study was not designed to allow evaluation of the accuracy of the various diagnostic procedures, in our experience CT seems the most efficacious for evaluating a suspected calcified adrenal mass. It correctly identified all calcified adrenal masses, correctly revealed all calcified adrenals without a mass, and was also extremely useful for showing the other characteristics of the mass containing calcification. Biochemical and vascular studies were of course extremely valuable in selected cases.

## Conclusions

Of 106 adrenal masses of a variety of causes, 33 contained calcification. Review of these cases shows that the presence of calcification within the adrenal mass is nonspecific, indicating neither a particular cause nor malignancy. Examination of all imaging characteristics as well as the presence and pattern of calcification and correlation with clinical and biochemical features usually indicates the correct diagnosis. Only adrenal cyst shows a specific pattern of calcification, with calcium limited to the periphery of a nonenhancing mass. A CT scan is the most useful procedure to detect whether suprarenal calcium lies within an adrenal mass.

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