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Original Article

Multi-modality Cross-Sectional Imaging Features of Adrenal Lesions: A Three-Case Series of Pheochromocytomas

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ABSTRACT

Pheochromocytomas are rare tumors arising from chromaffin cells that result in the synthesis, metabolization, and secretion of catecholamines and their metabolites. The classical triad of symptoms are headaches, tachycardia, and diaphoresis. Though, there is a spectrum of clinical presentations associated with these tumors, radiological assessment, particularly through computed tomography (CT) and magnetic resonance imaging (MRI), plays a pivotal role in achieving precise diagnosis and formulating effective treatment plans. These imaging modalities provide comprehensive insights into pheochromocytomas, aiding in their differentiation from other lesions and guiding therapeutic decisions.

Keywords: *Pheochromocytoma, catecholamines.*

INTRODUCTION

Pheochromocytomas are rare but life threatening condition that has varied clinical presentations particularly hypertension, headache, palpitation, and sweating. Patients with suggestive clinical features are investigated for Pheochromocytoma. The medical diagnosis in this tumor has increased with the improved availability of diagnostic laboratory tools particularly plasma or urinary fractionated metanephrines (metanephrine and normetanephrine), and other neuroendocrine markers particularly chromogranin A. The wide and universal availability of different imaging facilities, both contrast enhanced CT and MRI has improved the detection of Pheochromocytoma.

MATERIALS AND METHODS

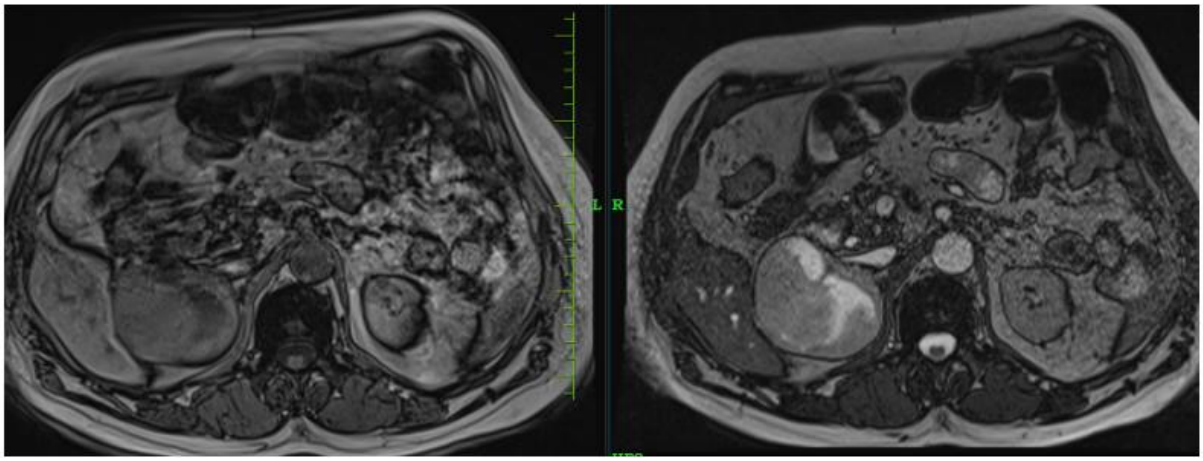
Three adult patients undergoing diagnostic evaluation for adrenal masses between January 2025 and February 2026 were retrospectively reviewed. All patients underwent either contrast-enhanced CT or MRI, including in-phase and out-of-phase chemical-shift imaging. Biochemical data and surgical or histopathologic results were correlated with imaging findings when available.

RESULTS

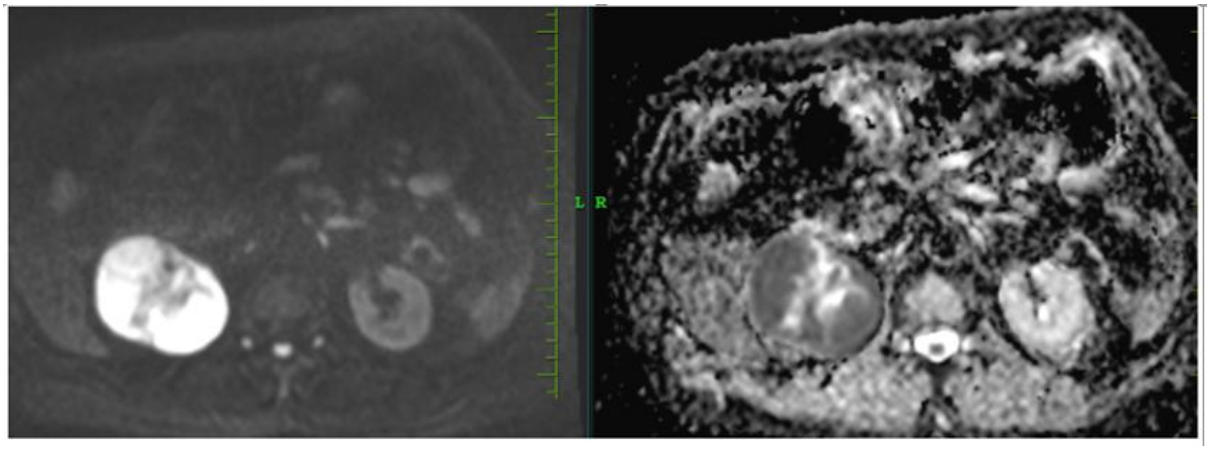
Case 1:

A 47-year-old male presented with history of hypertension, episodic palpitations and headache for last 2 years. He was referred for MRI abdomen with adrenal protocol which revealed a large well defined altered signal intensity mass lesion in the right suprarenal region measuring ~ 7.9 x 7.5 x 6.5 cm (APxTRxCC). The mass lesion appeared iso-intense on T1,

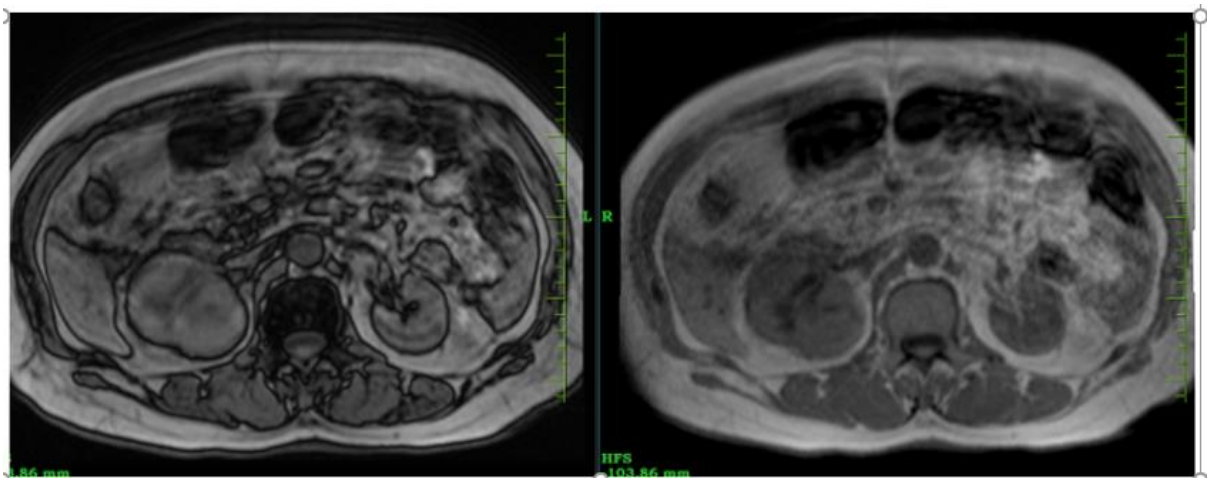
heterogeneously hyperintense on T2WI with few cystic/necrotic areas within. [Figure 1 A, B]. On diffusion weighted images the lesion showed true restriction on diffusion. [Figure 1 C, D] On chemical shift imaging (in and opposed phases) the mass lesion did not show any signal drop. [Figure 1 E, F] The mass lesion was seen displacing the right kidney inferiorly with maintained fat planes. Imaging findings were consistent with pheochromocytomas which was confirmed on post surgical excision biopsy.



[Figure 1 A, B]. Axial T1WI shows well defined iso-intense mass in right suprarenal region which appears heterogeneously hyperintense on T2WI with few cystic / necrotic areas within.



[Figure 1 C, D]. On diffusion weighted images the lesion showed true restriction on diffusion.

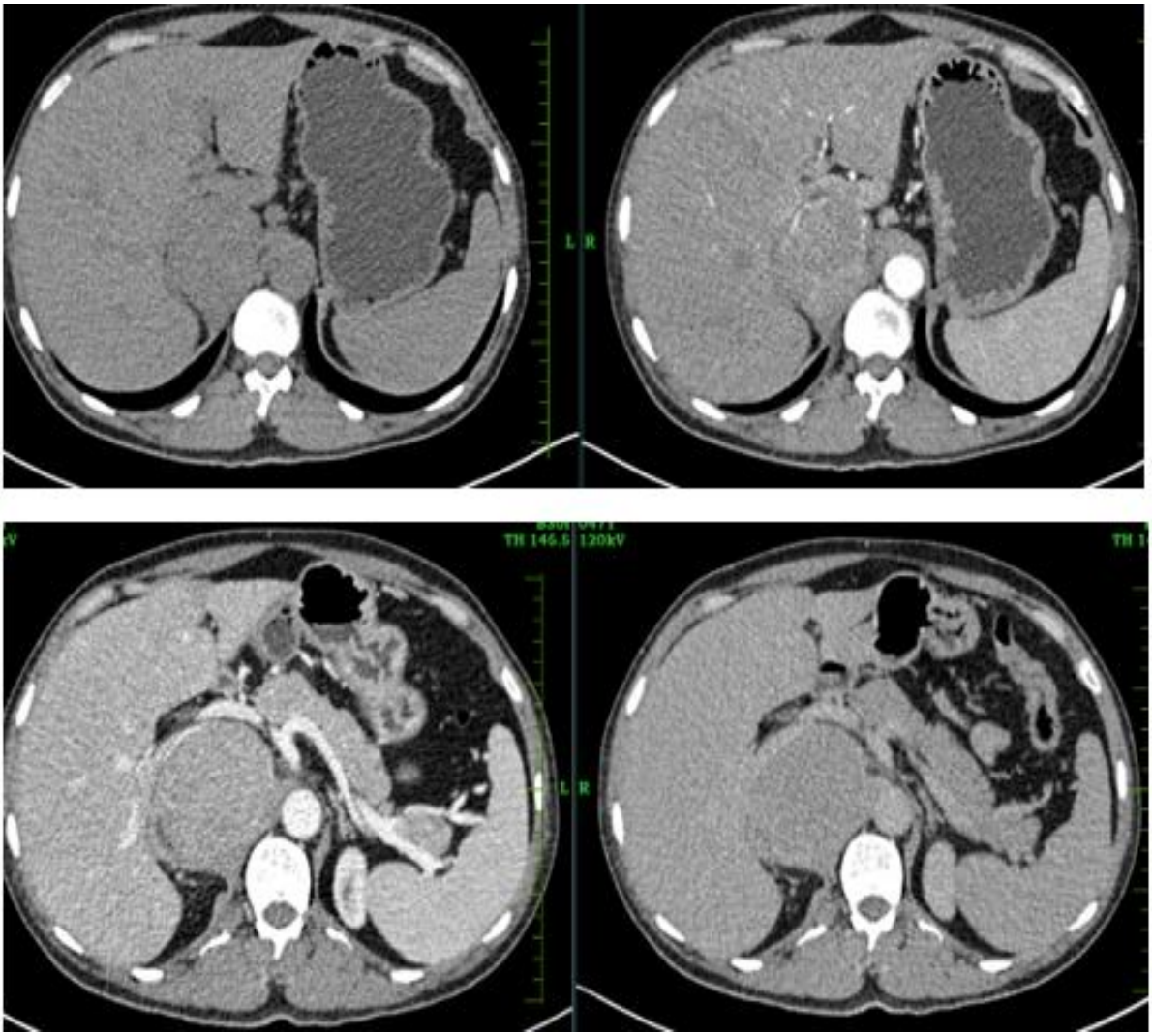


[Figure 1 E, F] On chemical shift imaging (in and opposed phases) the mass lesion did not show any signal drop.

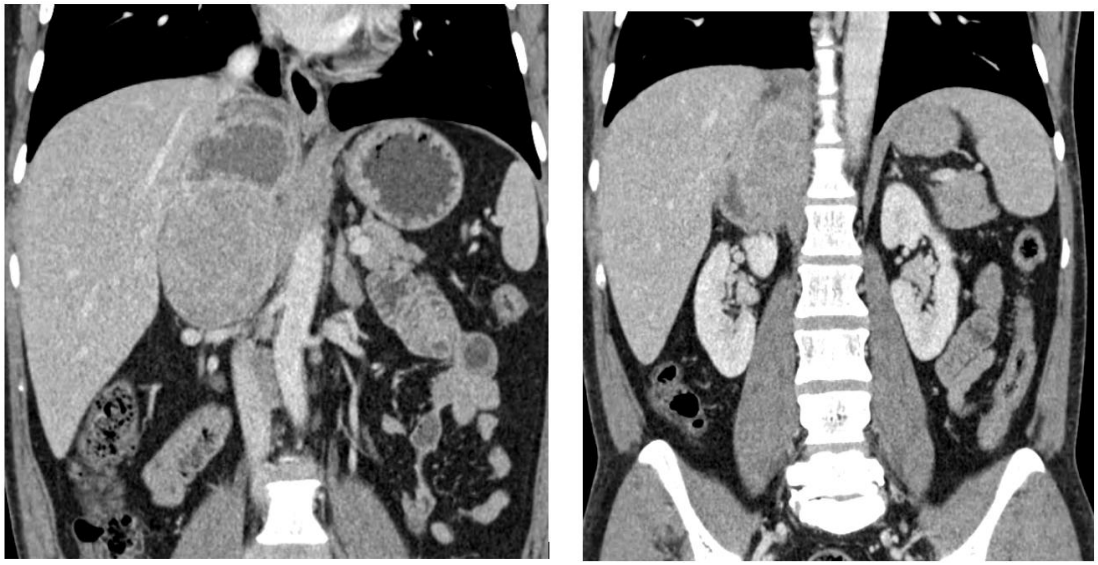
Case 2:

A 42-year-old male patient presented with episodes of palpitations accompanied by increased sweating and dizziness for last 2 years. He had history of hypertension for last 3 years. He had elevated levels of free plasma metanephrines (373.07 ng) and normetanephrines (1969.49 ng/l). Ultrasound abdomen showed right suprarenal heteroechoic mass lesion. He was referred for CECT abdomen and pelvis which revealed a large well defined heterogeneously enhancing solid cystic (predominantly solid) mass lesion, measuring ~ 7.2 x 6.3 x 10.3 cm (AP x TR x CC) in right suprarenal retroperitoneal region with few cystic areas at the superior aspect. No calcification, fat attenuation or hemorrhagic areas were seen within. Right adrenal gland could not be seen separately from the lesion. The mass lesion was supplied by a branch from abdominal aorta just above the origin of celiac trunk in the left paramedian region and was seen traversing superiorly and peripherally along the mass lesion.

Anteriorly the mass was seen displacing the portal vein and inferior vena cava anteriorly with no obvious thrombus seen within. Superiorly it was abutting the medial aspect of crus of right hemidiaphragm with loss of fat planes. Inferiorly and posteriorly the mass was seen extending into right perinephric space and causing mild compression of the superior pole of right renal parenchyma and displacing the renal vessels inferiorly. Multiple enlarged lymph nodes were noted in the celiac axis, aorto-caval, left para-aortic region largest measuring ~ 2.6 x 1.0 cm in aorto-caval region. Imaging characteristics compounded with clinical and laboratory findings were suggestive of right adrenal malignant variant of pheochromocytoma which was confirmed on excision biopsy of the mass and regional lymph nodes.



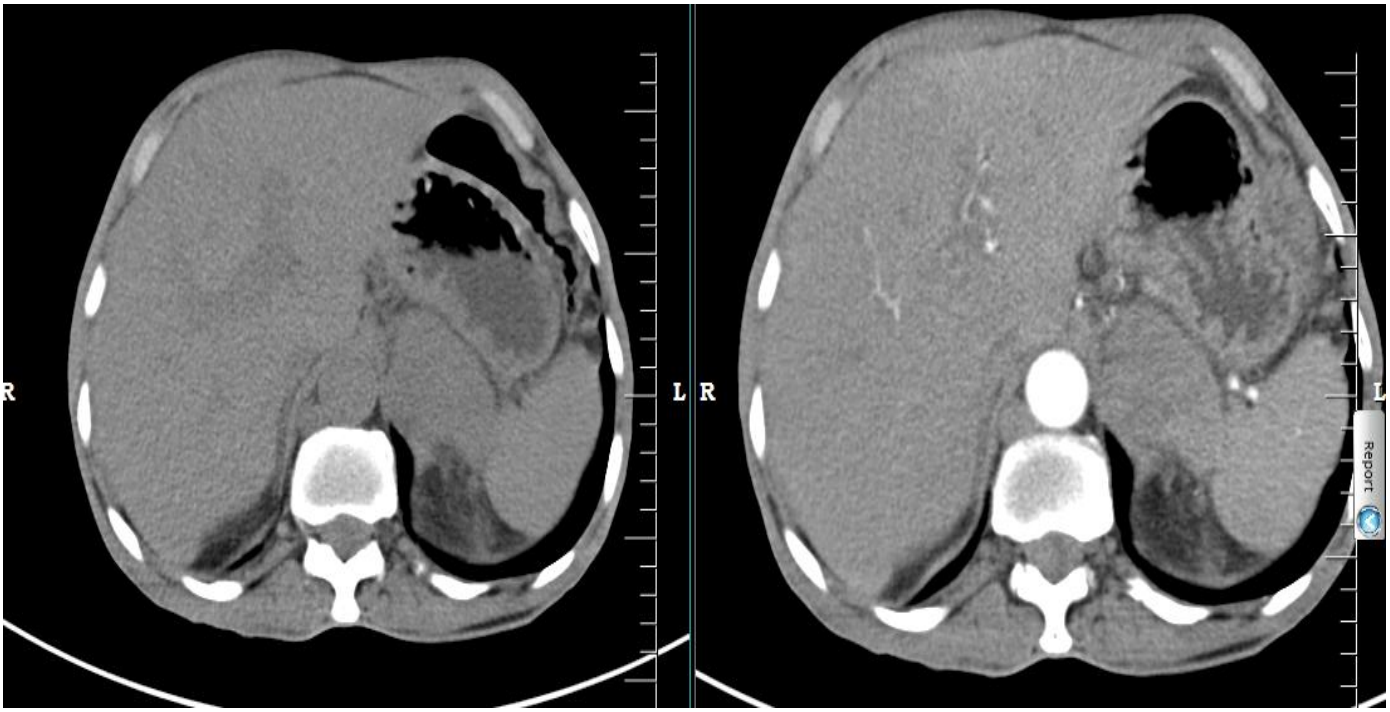
[Figure 2 A, B, C & D] CECT abdomen and pelvis axial images shows large well defined heterodense mass lesion in the right suprarenal region on NCCT image (2-A) which shows heterogeneous enhancement in arterial (2-B), venous (2-C) and delayed phase (2D).

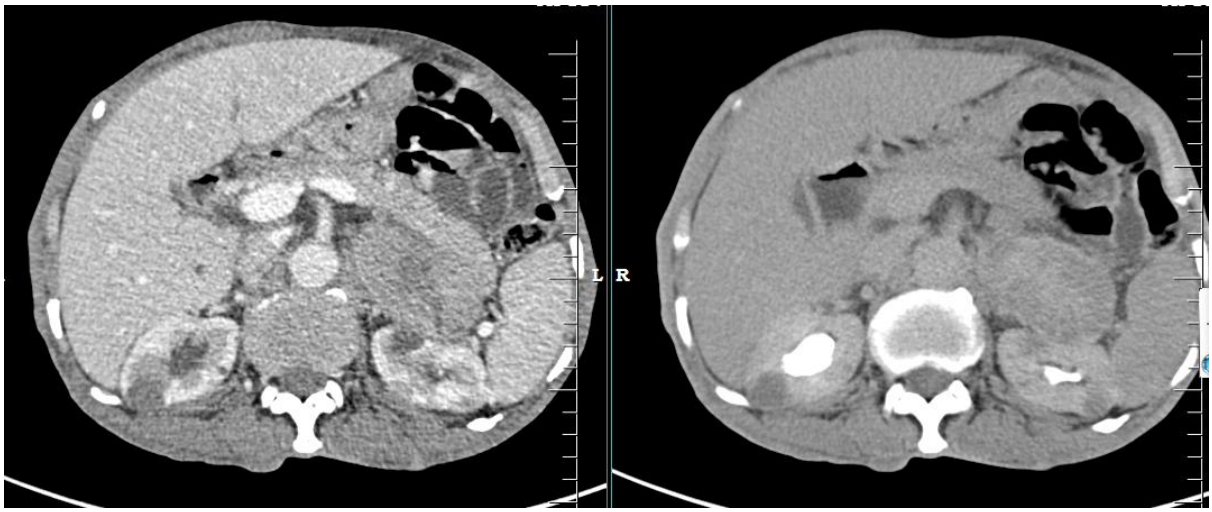


[Figure 2 E , F] CECT abdomen and pelvis coronal images shows heterogeneously enhancing mass lesion in the right suprarenal region with non-enhancing cystic/necrotic component.

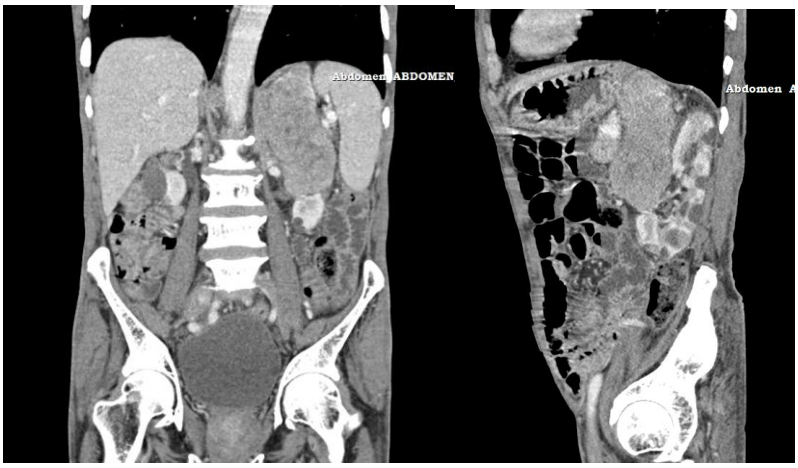
Case 3:

A 61-year-old male patient presented with refractory hypertension and palpitations with on and off sweating. CECT abdomen and pelvis revealed a large well defined heterogeneously enhancing mass lesion, measuring 5.0 x 5.0 x 11.2 cm (AP x TR x CC), in the left suprarenal location with few non enhancing central necrotic areas within. Left adrenal gland could not be separately made out. Superiorly the mass was seen abutting the left hemidiaphragm. Inferiorly and posteriorly it was seen extending into left perinephric space and causing mild compression of the underlying left renal parenchyma. Anteriorly the mass was seen abutting the pancreatic body, tail, splenic vein, adjacent small bowel loops with maintained fat planes. Medially, it was seen reaching upto the midline, but not crossing it and laterally it was seen abutting the spleen with well-maintained fat planes. Imaging findings were consistent with a pheochromocytomas which was confirmed on surgical biopsy.





[Figure 3 A, B, C & D] CECT abdomen and pelvis axial images shows large well defined heterodense mass lesion in the left suprarenal region on NCCT image (2-A) which shows heterogeneous enhancement in arterial (2-B), venous (2-C) and delayed phase (2D).



[Figure 3 E, F] CECT abdomen and pelvis coronal and sagittal reformatted images shows large heterogeneously enhancing mass lesion in the left suprarenal region reaching superiorly upto the left hemidiaphragm

DISCUSSION

Catecholamine producing pheochromocytomas tumors are neuro endocrine tumors that affect the chromaffin cells of adrenal medulla and postganglionic fibers of the sympathetic nervous system. These tumors are characterized by the synthesis, storage, release, and secretion of catecholamines and their metabolites. They include pheochromocytomas in the adrenal medulla and paragangliomas in the extra-adrenal sympathetic ganglions usually below the diaphragm in the retroperitoneum or organ of Zuckerkandl and various sites including the head, neck, thorax, and abdomen. However, although the majority of these tumors are benign and adrenal, investigation work up should consider their tendency for being multiple, malignant, and familial with genetic pathogenesis.

Pheochromocytomas can affect individuals of all ages. They are common in people aged between 40 and 50 years, and relatively more common among females. Adrenal pheochromocytomas constitute nearly 85% of cases of pheochromocytomas, with 15% being extra adrenal paragangliomas that affect the sympathetic ganglions anywhere from the base of the brain to the urinary bladder.

Because of their varied clinical, imaging, and pathologic appearances, accurate diagnosis can be challenging. The various imaging appearances on ultrasound, CT, MRI, and functional imaging can be complementary and have features that are useful for differentiating pheochromocytoma from other lesions of the adrenal.

Following diagnosis, removal of the adrenal gland or the tumor is done by open surgery or by the laparoscopic technique, which is considered the ‘gold standard’ treatment choice since 1992.
In this case series, we describe 3 patients that were found to have clinical features correlating with pheochromocytomas. Case 1 and case 2 had classical symptoms. Case 1 had no genetic association. Although case 2 appeared to be a rare form

with the possible presence of a metastatic adrenal carcinoma. Moreover, case 3 had an incidental finding of an adrenal mass on imaging, thus leading to further testing. Across cases, pheochromocytomas demonstrated intense vascular enhancement, high T2 signal, and preserved out-of-phase signal. The adrenal neoplasm exhibited irregular morphology, necrosis, and low lipid content, aiding differentiation from lipid-rich adenoma and other benign lesions.

CONCLUSION

Multiphase CT and MRI, particularly chemical-shift imaging, are essential for accurate characterization of adrenal lesions. Recognition of hallmark features—such as avid arterial enhancement and T2 hyperintensity in pheochromocytomas—facilitates timely diagnosis, while atypical or aggressive morphologic features should prompt consideration of adrenal neoplasm. This case series highlights the diagnostic value of CT and MRI in evaluating adrenal pathology.

Conflict of Interest: None declared.

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