ejpmr, 2016,3(12), 639-645

SJIF Impact Factor 3.628

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

ADRENAL MASSES: CHARACTERIZATIONS WITH CT AND MR IMAGING

Hoda Mahmoud Abd Elwahab[1]* and Saher Mohamed Ismail[2]

[1]Radiodiagnosis Department – Faculty of Medicine, for Girls – AlAzhar University, Cairo.
[2]Internal Medicine Department – Faculty of Medicine, for Girls – AlAzhar University, Cairo.

***Corresponding Author: Hoda Mahmoud Abd Elwahab**
Radiodiagnosis Department – Faculty of Medicine, for Girls – AlAzhar University, Cairo.

Article Received on 22/10/2016 **Article Revised on 12/11/2016** **Article Accepted on 0/12/2016**

ABSTRACT

Background: Adrenal mass are found incidentally in up to 5-8% of patients undergoing CT or MRI examinations for other purposes. The non-invasive characterization of adrenal lesions continues to improve with current cross-section imaging modalities. The aim of this work is to highlight how imaging techniques such as CT densitometry, CT washout and chemical shift MRI characterize the most of adrenal lesions and help in differentiating benign from malignant lesions. **Design:** Prospective study. **Patient and Methods:** Twenty-five patients had (26) adrenal lesions. Out of them (24) patients had solitary lesion and only one patient had bilateral adrenal lesions. Un-enhanced CT scan was the initial investigation followed by washout CT if the proper diagnosis couldn't be reached. Chemical shift MRI was done in (15) cases, while fat saturation was applied in (3) of them. Biopsy was done for 3 cases to confirm the diagnosis. The total imaging results as well as the pathological results were analysed. **Result:** Twenty six adrenal masses consisted of (10) adenomas, (9) metastases, (3) myelolipomas, (3) pheochromocytomas and (1) cyst. In washout CT, a mean absolute percentage washout (APW) and relative percentage washout (RPW) for adenoma were 74% and 68% respectively. For metastases, were 32% and 20% respectively. In chemical shift MRI, ademomas showed drop of signal intensity on the out of phase relative to the in phase image, in contrast to metastases which showed no drop of signal intensity. **Conclusions:** Various CT and MR imaging modalities, Proved that CT being the most important and available technique to differentiate benign form malignant adrenal lesions. Identification of benign lesions is warranted to reduce the number of unnecessary surgery and follow-up examinations in such patients.

KEYWORDS: Adrenal mass – Washout CT – Chemical shift MRI.

INTRODUCTION

Adrenal masses are estimated to occur in approximately (9%) of the general population. About (5 - 8%) of computed tomography (CT) and magnetic resonance imaging (MRI) studies of the abdomen demonstrate incidentally detected adrenal lesions.[1]

Adrenal "incidentalomas" are defined as adrenal masses larger than 1 cm in patients for whom imaging studies are being performed for an unrelated indication.[2,3] The frequency of adrenal incidentalomas has been found to correlate with increasing age, with (0.2%) detected in CT studies performed in subjects aged (20-29) years.[4,5] Approximately (90%) of these lesions are benign non-functioning adenomas.[6]

Once an adrenal lesion is discovered, two basic questions need to be answered. First, is the lesion benign or malignant? Next, if benign, is the lesion a functioning or non-functioning mass?[7] The question can directly affect the clinical management of the case.[8]

In the case of a primary malignancy and/or functioning adrenal mass, surgery is currently the first-line treatment of choice. Functional adrenal masses represent a small percentage of adrenal tumors.[7]

The adrenal gland is the fourth most common site of metastases, and adrenal metastases may be found in as many as (25%) of patients with known primary lesions.[8] In the setting of widespread metastatic disease, it is not critical if the adrenal gland is one of many sites of metastasis. However, if the adrenal gland is the solitary focus of spread, accurate characterization is imperative, as it advances the patient's stage of disease, affecting treatment and prognosis.[9]

Unenhanced CT, however, is often the key series in the evaluation of incidentalomas or potential adenomas.[10] If the adrenal mass is less than 10 Hounsfield (HU), a diagnosis of adrenal adenoma can be made. If the adrenal mass is more than (10 HU), CT with intravenously administered contrast material should follow, and the washout should be calculated. Benign lesions typically demonstrate more than 50% washout. In cases in which CT findings are equivocal, chemical shift MRI should be performed. When the findings of both modalities are

inconclusive, biopsy is advised only when a known extra-adrenal malignancy is present.[8]

Patients and Methods

The study was carried out at the department of radiology in Alzahraa university Hospital and some private radiologic centers during the period from (2013 – 2016). Informed consent were taken from participating patients. The study included 25 patients (15) males and 10 females aged (25 to 75) years old mean age (48.6±13.23 years) had 26 adrenal masses with size range (1.5-6 cm) mean (3.2±1.8). The patient were referred from internal medicine, surgery and urology departments, their complaints were abdominal pain, abdominal mass, headache, chest pain and cough. Eight of this patient had extraadrenal malignant tumors, (4) bronchogenic carcinoma, (2) breast cancer, (1) colonic cancer and (1) bladder cancer.

Inclusion criteria

1- Incidental adrenal masses (or adrenal incidentalomas).
2- Patients with a known cancer and quiree adrenal metastasis.
3- Adrenal lesion with excessive hormone production include: cortisol, aldosterone, androgen or catecholamine.

Exclusion criteria in CT scan

- Patient with renal impairment.
- Known cases of hypersensitivity for contrast media.

Patient with MRI contraindication as

- Patients who have a heart pacemaker.
- Patients who have a metallic foreign body (metal sliver) in their eye, or who have an aneurysm clips in their brain.
- Patients with severe claustrophobia.

When an adrenal incidentaloma lesion was detected, first we checked the clinical examination for subtle signs and symptoms of adrenal dysfunction and the laboratory work-up 24-h urinary catecholamine excretion or plasma metanephrines, serum cortisol, serum aldosterone and plasma rennin activity (in hypertensive patients only) to exclude functional lesions. Then we asked about a known history of primary extra adrenal malignancy and prior/serial imaging to assesses the stability of a lesion.

Adrenal CT without intravenous contrast enhancement was obtained by using (Toshiba-Aquilion-Prime 160 slice Japan). Imaging parameters included section collimation of (3–5 mm), high-quality mode, table speed of (7.5 mm/ sec), (50%) overlap reconstruction, (120 kV and 280–380 mA).

The general morphologic features were assessed and the densitometry measurement were made through the centre of the lesion to prevent partial volume averaging of adjacent retroperitoneal fat. A circular region of interest (ROI) covered at least (½ - ⅔) of the surface area of the lesion away from areas of calcification, bleeding or necrosis.

A small lesions (< 4 cm in diameter) with an (HU < 10) were followed for 6 months.

In a large lesions (>4cm) with non-contrast density of (>43 HU), we complemented with contrast enhanced CT, water soluble contrast media (ominpaque) in dose (1-1.5ml/kg) up to a maximum of 125ml was administered intravenously at a rate of (2-3ml/sec.). Contrast-enhanced images were obtained at (1 and 10 minutes).

Absolute percentage washout (APW) and Relative percentage washout values (RPW) were calculated

APW = [(enhanced HU) – (10 min delayed HU) / (enhanced HU) – (unenhanced HU)] x 100

RPW = [(enhanced HU) – (10 min delayed HU) / (enhanced HU)] x 100

Cases in which, (APW < 60) and (RPW < 40) chemical shift MRI was performed.

Adrenal MR imaging was performed with a (1.5 T) unit with a phased-array body coil in (15) patients. T1-weighted spin echo axial images were obtained. T2 weighted axial and coronal images were obtained with the fast spin echo technique. The section thickness was (4 mm) with an intersection gap of (0.4 mm) for both T1 and T2 weighted imaging. Fat saturation was used for the T2 weighted fast spin echo images in (3) patients. Chemical shift imaging was performed using a T1-weighted gradient recalled echo sequence with breath-holding with a TR of (68–160 ms) and a TE of (4.9 ms) for in-phase images and a TE of (6.3) ms for out of phase images. The flip angle was (30), the matrix size was (128 – 256) and the field of view varied from (320 to 375 cm). Qualitative assessment of the chemical shift images was done to determine whether significant drop of signal had occurred in the lesion on the out of-phase relative to the in-phase images.

Biopsy was done in (3) cases as the finding of both CT and MRI modalities were inconclusive.

RESULT

Twenty-four patients had unilateral adrenal lesions and (1) patient had bilateral adrenal lesions were evaluated at this study. The identified lesions were (10) adenomas, (3) myelolipomas, (3) pheochromocytomas, (1) cyst and (8) metastases out of them (7) had unilateral adrenal metastases and (1) had bilateral adrenal metastases Fig. (1).

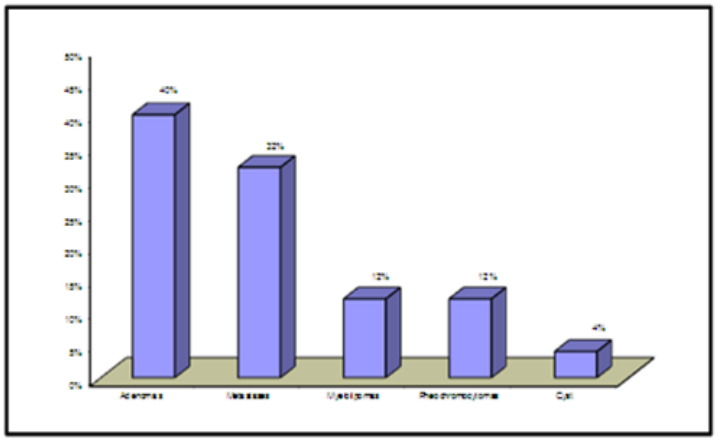


Figure (1): Showing the distribution of adrenal mass by diagnosis.

Twenty lesions were incidentaloma.

Eight adenomas were non functioning and diagnosed with unenhanced CT. It were small (1.5-3cm in diameter), well-defined, smoothly marginated, homogenous lesion with an (HU <10) followed up with unenhanced CT at 6 months which proved the stability of lesions Table (1).

Two atypical adenomas with unenhanced density (>10 HU), the diagnosis confirmed by (10) minute delayed washout CT and chemical shift MRI. Adenomas lost contrast more rapidly compared to non-adenomas. Absolute percentage washout (APW) and relative percentage washout (RPW) were calculated: (APW 74% ±15) and (RPW 68% ± 12), in the other case (APW 83.7%) and (RPW 51.6%) Table (1 & 2).

Chemical shift MRI (in-phase and opposed phase) also showed significant drop of signal intensity on (out of phase) in comparison to (in Phase) consistent with adenoma Fig. (2).

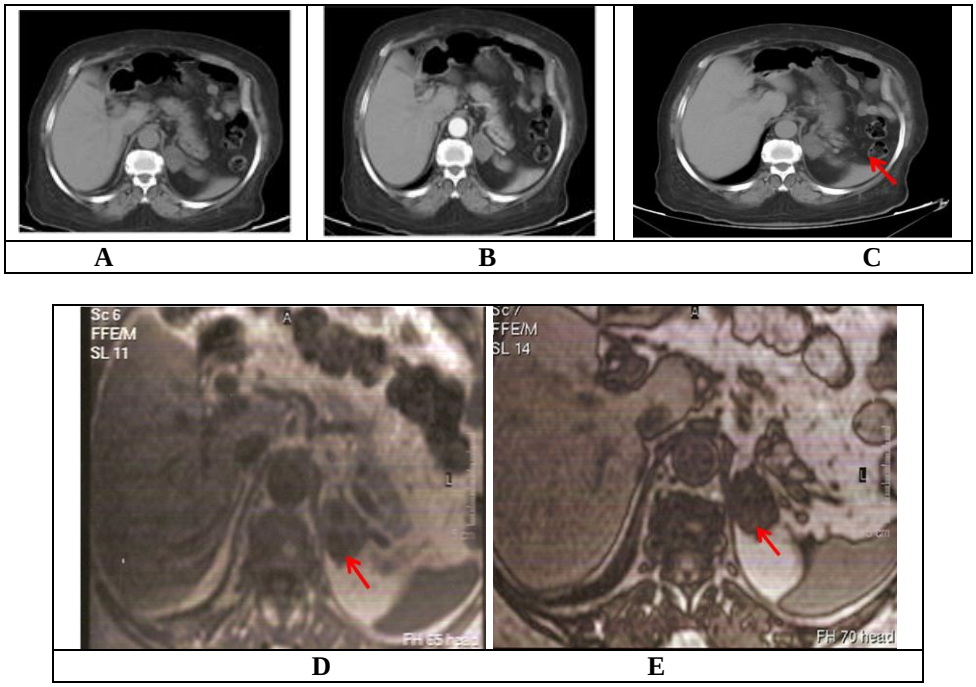


Fig. (2): Male patient, 69 years old, complaint: Recurrent attacks of nonspecific abdominal pain. Normal Laboratory tests, 10 minute delay washout CT (A) precontrast, (B) early contrast enhancement and (C) delayed images, axial scan, well defined left adrenal mass with rapid contrast wash out APW 83.7% and RPW 51.6%, chemical shift MRI (D) in phase (E) out in Phase: the lesion showed drop of signal intensity on out of phase relative to in phase. Finding consistent with left adrenal adenoma.

Seven patients with known cancer had large adrenal (3-6 cm) heterogeneous masses with areas of hemorrhage and necrosis. Unenhanced density (>10 HU), (mean APW 32% and mean RPW 20%), the masses did not demonstrate signal suppression on chemical shift imaging finding consistent with metastases Fig. (3) & Table (1 & 2).

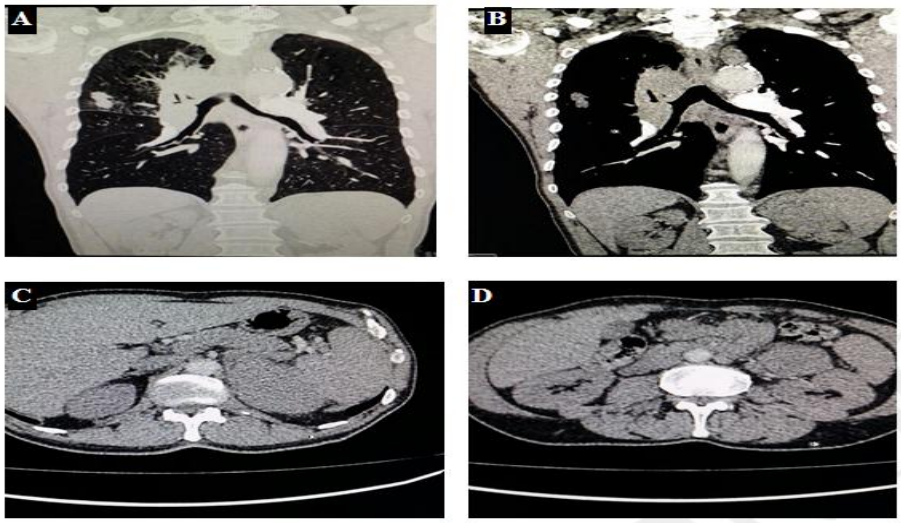


Fig (3): Male patient 75 years old, complaint: dyspnea and cough, normal laboratory tests, chest CT with contrast administration coronal A) lung and B) mediastinal windows, Two, small spieculated pulmonary nodules at right upper lobe, another large one noted abutting the superior mediastinum multiple mediastinal lymphadenopathy, (C&D) axial scan of upper abdominal: large well defined, heterogeneous left adrenal mass with RPW 25% consistent with metastases and proved by biopsy (metastases of bronchogenic carcinoma).

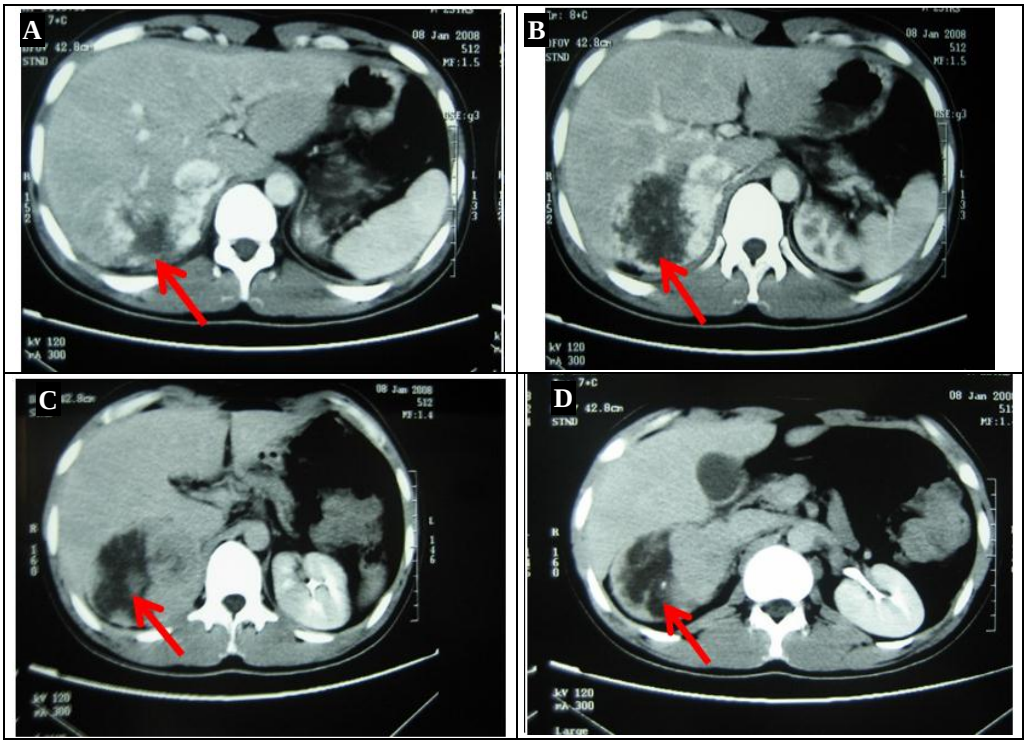
Only (1) case had bilateral small adrenal lesions (1.5 & 2 cm) with unenhanced density (> 10) and not demonstrate signal suppression on chemical shift imaging. Proved by biopsy to be metastases from bronchogenic carcinoma.

Percutanuous biopsy was done in 3 cases to confirm metastases, prior to it clinical and laboratory assessment performed to exclude the possibility of a pheochromocytoma.

Three cases of myelolipoma, the presence of macroscopic and bulk fat with (-ve) HU on CT and signal suppression on fat saturation MRI confirmed the diagnosis.

A case of cyst demonstrated as lesion of fluid attenuation on non contrast CT with lack of enhancement on enhanced CT and bright signal intensity on T2 MRI.

Out of (3) cases of pheochromocytoma (2) cases had typically T2 hyperintense signal and correlated with clinical and laboratory findings. The third one had T2 hetrogenous signal and confirmed by scintigraphy Fig (4).



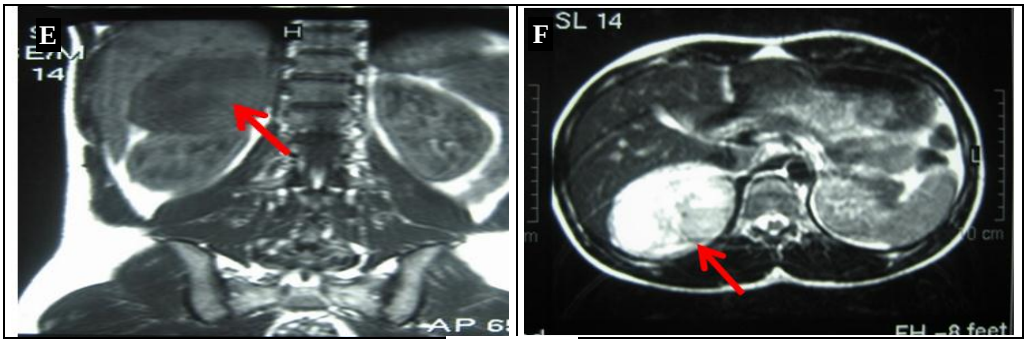


Fig. (4): Female patient, 28 years old complaints: Paroxysmal attacks of palpitation and headache, with adrenal laboratory findings, (A,B): Early CECT demonstrates the large heterogeneously enhancing right adrenal mass, (C,D) Delayed images show rapid contrast washout with large persistent necrotic areas and (E) coronal T1, (F) axial T2 (light bulb appearance) of right adrenal mass. Findings consistent with right adrenal pheochromocytoma,

Table (1): Characteristics of adenomatous and non adenomatous lesion.

		Adenomatous lesion	Non Adenomatous lesion
Size of the mass (cm)		2 ± 0.6	4.2 ± 0.9
Pre-contrast phase (HU)		8.5 ± 1.2	35 ± 7.2
Venous phase (HU)		77% ± 12.2	80 ± 11
Delayed enhanced phase (HU)		35% ± 5.5	64 ± 15
10-min Delayed washout rate	APW	74 % ± 15	32% ± 14
	RPW	68% ± 12	20% ± 9

cm, centimeter; HU, Hounsfield unit; APW, absolute percentage washout; RPW, relative percentage

Table (2): CT washout formulae for adenoma and malignant charachterisations.

Percentage washout	Washout values (%)	
	Adenoma	Malignant
Absolute % washout – APW	> 60	< 60
Relative % washout – RPW	> 40	< 40

E= enhanced attenuation value – 60 seconds; D= delayed enhanced value – 10 minutes; U= unenhanced attenuation value.

DISCUSSION

Out of twenty five examined patients, (24) patients had a unilateral adrenal lesions and one patient had bilateral adrenal lesions were evaluated in this study. The identified lesions were classified as (10) adenomas, (3) myelolipomas, (3) pheochromocytomas, (1) cyst and (8) metastases out of them (7) unilateral lesion and one bilateral lesions. Our result agreed with *Baker*[7] Who found the largest proportion being adenomas in (88) on (157) patients with adrenal masses.

Incidental, *Blake et al.*[11] Further adrenal lesions larger than 1 cm are seen in about 4.4% of all computed tomography (CT) scans.[7]

In our study, (20) lesions were incedentloma on (25) patients. Which were non functioning lesions. The result agreed with *Baltzer et al.*[12] who found the majority of AIs, even if present in cancer patients were nonfunctional and benign lesions account (82.5%) of their cases.

When an AI lesion is detected, a clinical examination checking for subtle signs and symptoms of adrenal dysfunction and a laboratory work-up to exclude functional lesions are mandatory. Functional lesions, such as cortisol-secreting lesions or pheochromocytomas, are associated with higher morbidity and mortality.[12]

We found only (4)patients with hyperfunctioning lesions on a laboratory work up.

Larger lesions are more likely to be malignant. In an adrenal lesion >4 cm, the chance of malignancy approaches (70%); and if >6 cm it approaches (85%).(9,11) A large lesion with heterogeneous attenuation and irregular contours is suspicious of malignancy, as compared with a small, well-defined, smoothly marginated, homogenous lesion which favours benignity. Large areas of intralesional necrosis are often associated with malignancy.(9, 13)

We found seven, large adrenal (3-6 cm) heterogeneous masses showed areas of hemorrhage and necrosis with unenhanced density (>10 HU). Unenhanced CT, combined by CT wash out and chemical shift MRI confirmed the diagnosis of metastases.

But (1) case not agreed with *Naidu and Singh*[9] as the patient had bilateral small adrenal masses with smooth border which proved to be metastases by biopsy.

Boland et al. [1]**,** in their meta-analysis concluded that (< 10 HU) on unenhanced CT had a (71%) sensitivity and (98%) specificity in diagnosing adenomas. To date, this threshold value of (<10 HU) has strong support in clinical practice and is the most widely endorsed standard value. It is proposed that any adrenal lesion with an (HU <10) is probably benign and no further investigations or serial follow-up is required.[7,8,13]

Our study found that (8) adenomas with unenhanced density (<10 HU). And (2) lipid poor adenomas with unenhanced density (>10 HU) in which, the diagnosis confirmed by CT washout.

Furthermore, ***Blake et al.***[1] recognized that a non-contrast density of (>43 HU) is highly suspicious of malignancy.

CT with washout assessment has been found to have a sensitivity of 100% and specificity of (80%) when the density is greater than 10 HU as compared to CS MR with (76%) sensitivity and (60%) specificity.[7]

If a 15-minute delay after contrast administration protocol is used, an absolute percentage washout of 60% or higher has reported sensitivity of 86–88% and specificity of (92–96%) for the diagnosis of an adenoma.[11,13] In similar fashion, if a 10-minute delayed protocol is used, sensitivity of 100% and specificity of 98% have been obtained for a threshold absolute percentage washout value of 52%.(11) If a 10-minute delay protocol is used, a relative percentage washout of 38–40% or higher has had reported sensitivity and specificity of 98% and 100% for the detection of adenoma. After 15 minutes, if a relative percentage washout of 40% or higher is achieved, sensitivity is 96% and specificity is 100% for the diagnosis of an adenoma.[11]

Both lipid-rich and lipid-poor benign adenomas show a faster wash-out of contrast medium than other adrenal masses.[12]

Although abbreviated, 10-min–delay CT protocols seem to provide high specificity.[12]
In our study the (10 min) delayed protocol was used and a threshold APW mean value of (74%) and RPW of (68%) was found for adenomas. As for metastases a threshold APW mean value of (32%) and RPW of (20%) was found.

However, in-phase and out-of-phase imaging (e.g., chemical shift imaging) can be used to diagnose adrenal cortical adenomas with (81-100%) sensitivity and (94-100%) specificity.

Out-of-phase chemical shift images of lipid-rich adrenal adenomas show a decrease in signal intensity. The signal intensity from the spleen can be used as a reference, and ensuring identical preimaging values with both sequences is important. A decrease of (20%) in the signal intensity on out-of-phase images relative to that on in-phase images is diagnostic.[8]

We used qualitative assessment of the chemical shift in (2) cases of atypical adenoma to confirm the diagnosis in which there were drop of signal intensity of adrenal lesions on the out of phase compared to the in phase image**.**

Certain imaging features in adrenal masses are diagnostic of benignity and require no-further workup. For example, a myelolipoma is easily recognized by the presence of macroscopic fat.[13]

We found bulk fat in the cases of myelolipoma with (–ve HU) on CT and signal suppression on fat saturation MRI techniques confirmed the diagnosis.
A case of cyst demonstrate fluid attenuation on non contrast CT and bright signal intensity on T2 MRI with lack of enhancement on enhanced CT.

Our result agreed with ***Chung and Song***[13] who considered, a non-enhancing adrenal mass of fluid density or signal with a thin wall is diagnostic of a simple cyst and require no further workup.

Imaging characteristics such as smooth margins and homogeneous density are typically observed in benign lesions and these “benign” morphologic features can also be present in small metastatic masses.

In (1) patient with bronchogenic carcinomam, we found bilateral small adrenal lesion with smooth margin mimic benign lesion by unenchanced CT and proved to be metastases by biopsy.

Comparison to prior imaging is essential in the assessment of an adrenal incidentaloma. An adrenal mass that demonstrates stability for at least one year is highly unlikely to represent metastatic or primary malignancy, making further imaging workup unnecessary.[13]

In our study, one case of myelolipoma showed slight increase in size n unenhanced CT follow up at 6 months.
Another case of bronchogenic carcinoma with multiple metastases not surgically treated showed increase in size of adrenal metastases at follow up.

Pheochromocytomas, although rare, may mimic both adenomas and malignant masses on both CT densitometry and washout[11]**,** and some authors strongly advise considering a pheochromocytoma if the contrast-enhanced CT value is very high, for example, more than (150 HU).[14]

In our study, (2) cases of pheochromacytomas diagnosed by MRI as it showed typically T_2 hyperintense singal and correlated with clinical and laboratory findings.

In these oncology patients with detected adrenal masses, about (50%) have adrenal metastasis on biopsy.[9]

In our study, we found (8) cases of metastases (7) unilateral and one bilateral and three cases confirmed by biopsy.

CONCLUSION

Various CT and MR imaging modalities, proved that CT being the most important and initial study to characterize adrenal lesions. Unenhanced CT and washout CT play an important role in differentiating adenoma from metastases. Benign lesions typically demonstrate more than 50% washout. In cases in which CT findings are equivocal, chemical shift MRI should be performed especially in patient with known primary malignancy. These techniques obviate the need for adrenal biopsies that are performed in indeterminate cases and reduce the number of unnecessary surgery and follow up examination in such patients. In addition, complications associated with these invasive techniques, may be avoided.

REFERENCES

1. Boland GW, Blake MA, Hahn PF, Mayo-Smith WW. Incidental adrenal lesions: principles, techniques, and algorithms for imaging characterization 1. Radiology, 2008; 249(3): 756-775.
2. Kloos RT, Gross MD, Francis IR, Korobkin M, Shapiro B. Incidentally discovered adrenal masses*. Endocrine Reviews, 1995; 16(4): 460-484.
3. Young WF. Management approaches to adrenal incidentalomas: a view from Rochester, Minnesota. Endocrinology and metabolism clinics of North America, 2000; 29(1): 159-185.
4. Mansmann G, Lau J, Balk E, Rothberg M, Miyachi Y, Bornstein SR. The clinically inapparent adrenal mass: update in diagnosis and management. Endocrine reviews, 2004; 25(2): 309-340.
5. Song JH, Chaudhry FS, Mayo-Smith WW. The incidental adrenal mass on CT: prevalence of adrenal disease in 1,049 consecutive adrenal masses in patients with no known malignancy. American Journal of Roentgenology, 2008; 190(5): 1163-1168.
6. Cawood TJ, Hunt PJ, O'Shea D, Cole D, Soule S. Recommended evaluation of adrenal incidentalomas is costly, has high false-positive rates and confers a risk of fatal cancer that is similar to the risk of the adrenal lesion becoming malignant; time for a rethink?. European Journal of Endocrinology, 2009; 161(4): 513-527.
7. Baker R. Adrenal Tumors: Anatomy, Physiology, Diagnosis, and Treatment, Mon, 01/26/2015.
8. Horwich PJ and Lin EC. Adrenal adenoma imaging. 2015 Nov; 10.
9. Naidu V and Singh B. Adrenal lesions encountered in current medical practice− a review of their radiological imaging. SA Journal of Radiology, 2013; 17(4).
10. Heinz-Peer G, Memarsadeghi M, Niederle B. Imaging of adrenal masses. Current opinion in urology, 2007; 17(1): 32-38.
11. Blake MA, Kalra MK, Sweeney AT, Lucey BC, Maher MM, Sahani DV, Boland GW. Distinguishing Benign from Malignant Adrenal Masses: Multi–Detector Row CT Protocol with 10-Minute Delay 1. Radiology, 2006; 238(2): 578-585.
12. Baltzer P, Clauser P, Klatte T, Walz J. Work-up of the Incidental Adrenal Mass. European Urology Focus, 2016; 1(3): 217-222.
13. Chung MTM and Song JH. Adrenal incidentalomas in 2014.
14. Johnson PT, Horton KM, Fishman EK. Adrenal Mass Imaging with Multidetector CT: Pathologic Conditions, Pearls, and Pitfalls 1. Radiographics, 2009; 29(5): 133.