KREP

2025

KARNATAKA RADIOLOGY EDUCATION PROGRAM

DR MUTHU MANGALA , DNB RESIDENT NH

CASE 1:

- 63 year old man ,k/c/o Diabetes mellitus , on Glimepiride since Jan 2023 , k/c/o Hypertension since 2 years on Tab Losartan
- Presents with history of fever , evening rise of temperature , weight loss and body aches since 8 months
- No h/o contact with TB, exposure to birds, recent travel .

VITALS

Blood Pressure: 142/94mmHg

Heart Rate: 107 bpm

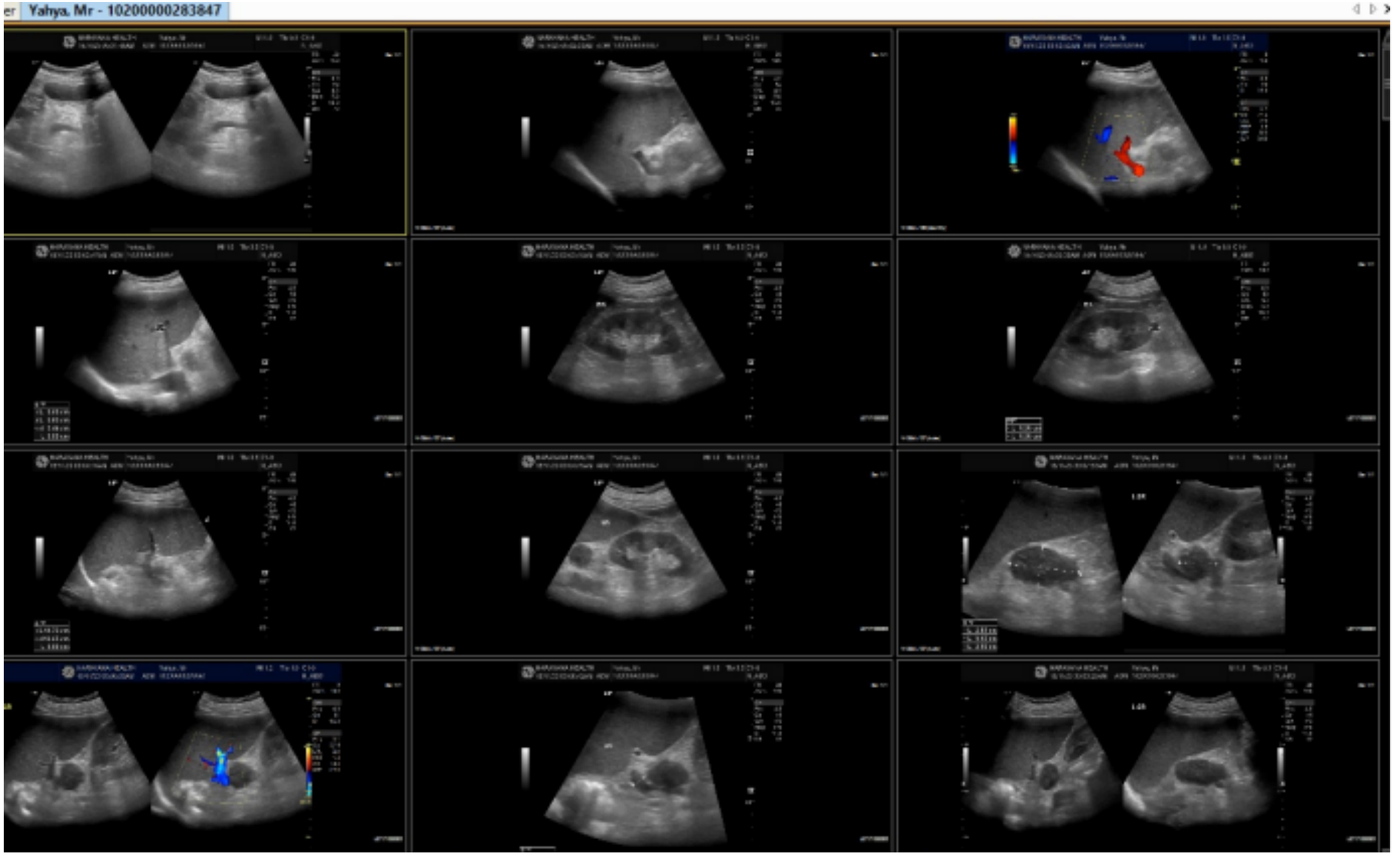
- **USG abdomen -**

-->Simple hepatic cysts

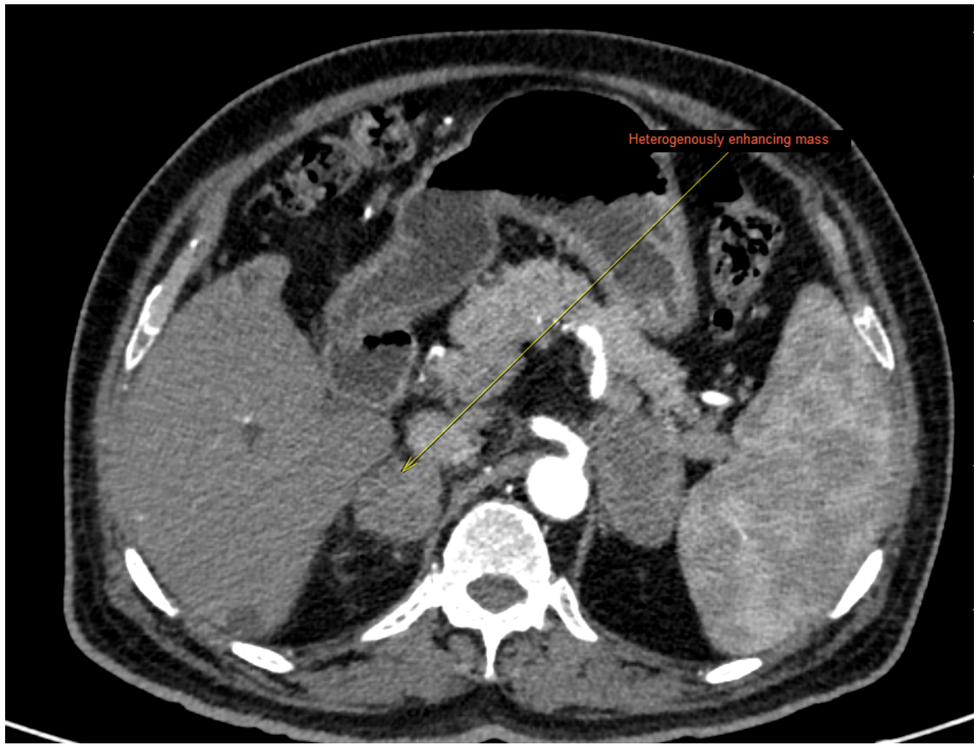
-->Splenomegaly

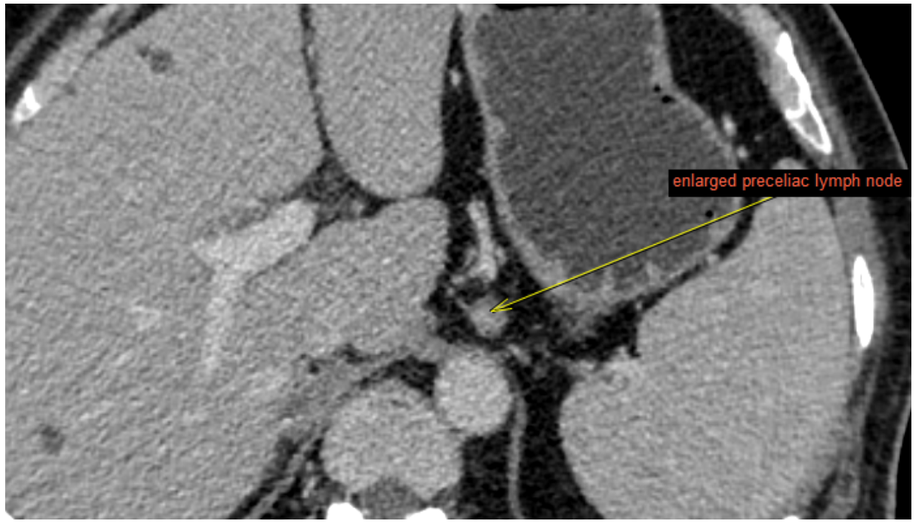
-->Well-defined heterogeneously hypoechoic lesion in the bilateral suprarenal regions - ?Adrenal lesions

In view of adrenal lesion , CT scan is advised.

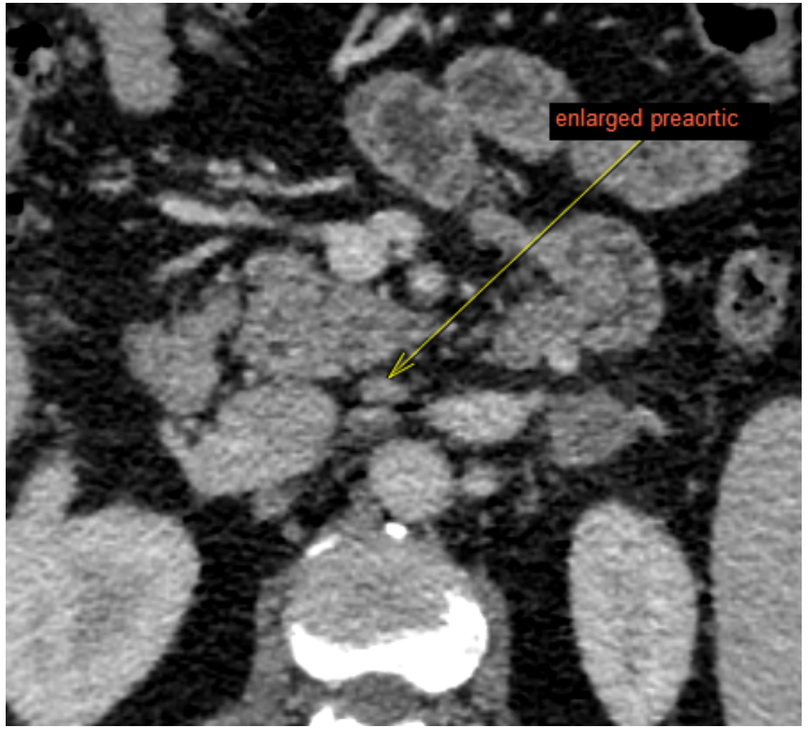

Yahya, Mr - 10200000283847

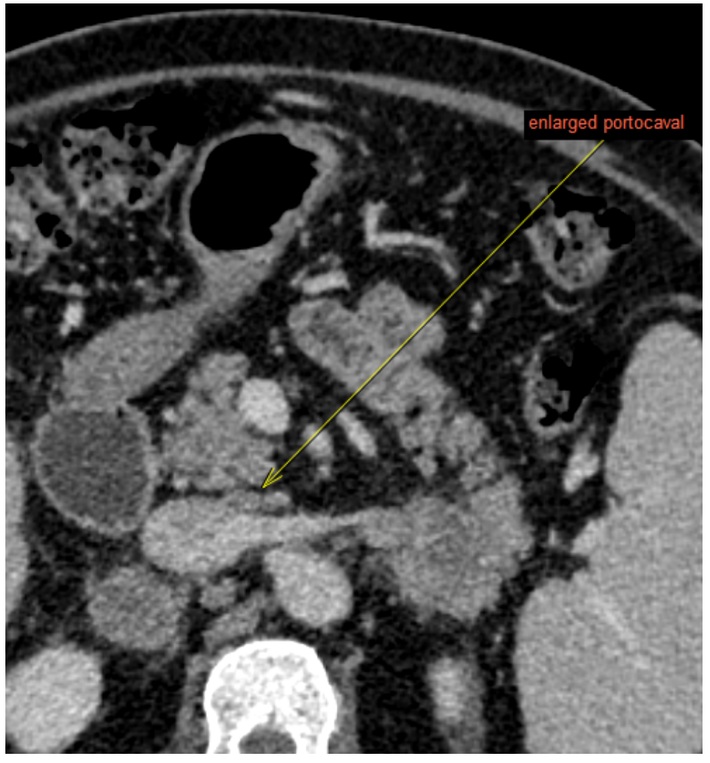
KEY IMAGES

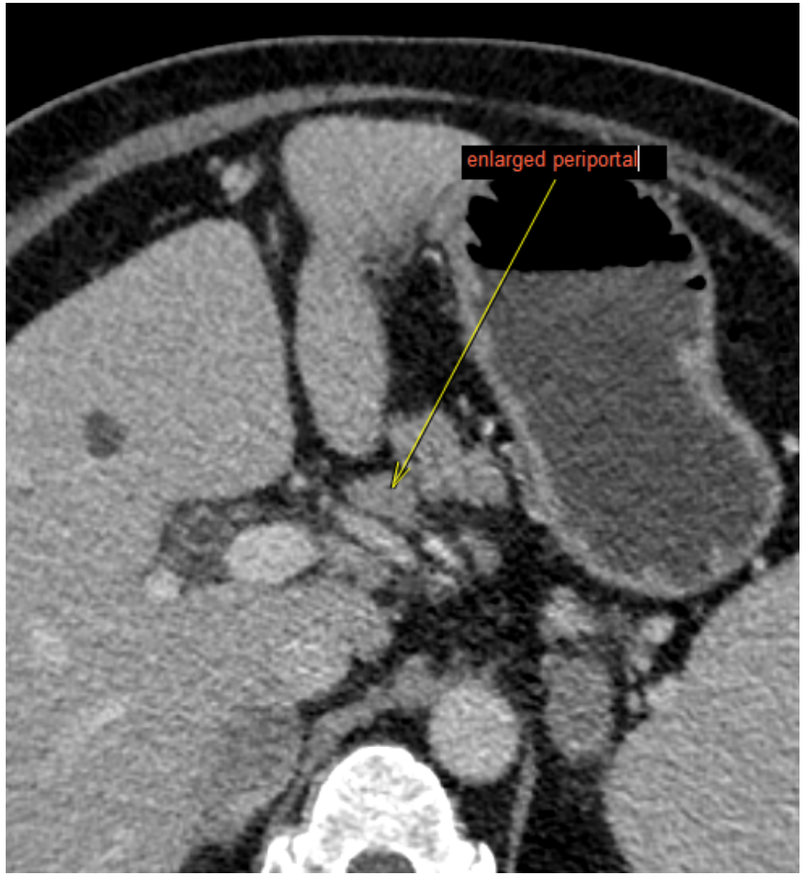

Heterogenously enhancing mass


enlarged preceliac lymph node


enlarged perigastric


enlarged preaortic


enlarged portocaval

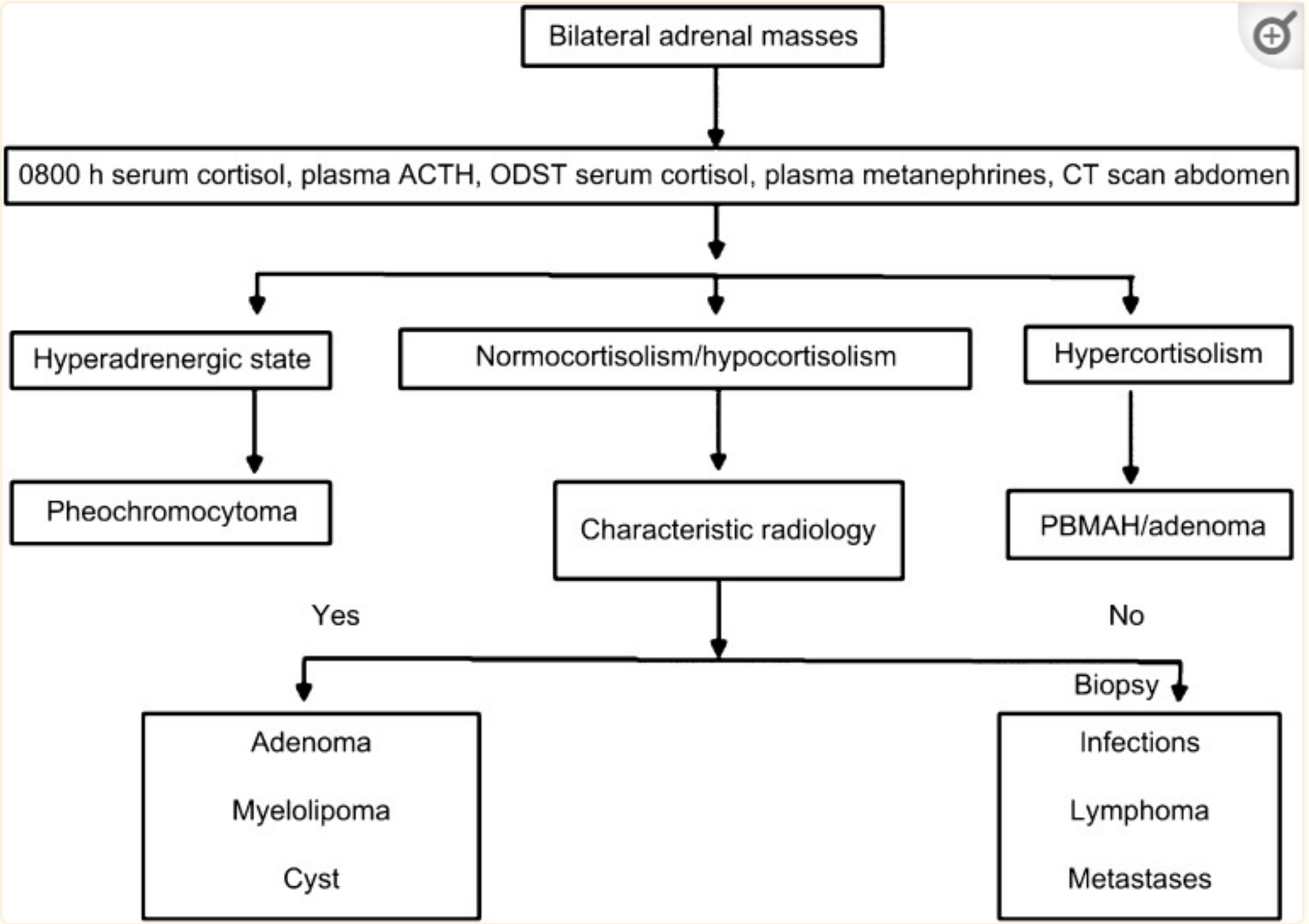

enlarged periportal

FINDINGS:

- Enlarged bilateral adrenal glands , showing attenuation of 40 HU on plain study and heterogeneous enhancement with absolute wash out of < 60 %
- No calcification / fat density
- Lesion in the right adrenal gland abutting the liver with loss of fat plane and the lesion in the left adrenal gland abutting the tail of pancreas
- Multiple enlarged homogeneously enhancing perigastric, preaortic, paraceliac, periportal, portocaval lymph nodes
- Normal sized liver showing multiple non enhancing cysts
- Splenomegaly

DIFFERENTIAL DIAGNOSIS FOR BILATERAL ADRENAL MASSES :

- Tuberculosis / Histoplasmosis
- Lymphoma
- Metastasis
- Pheochromocytoma
- Adrenal cortical hyperplasia
- Adrenal hematomas


Bilateral adrenal masses
0800 h serum cortisol, plasma ACTH, ODST serum cortisol, plasma metanephrines, CT scan abdomen
Hyperadrenergic state
Normocortisolism/hypocortisolism
Hypercortisolism
Pheochromocytoma
Characteristic radiology
PBMAH/adenoma
Yes
No
Biopsy
Adenoma
Myelolipoma
Cyst
Infections
Lymphoma
Metastases

BIOCHEMISTRY

Test	Result	Unit
Serum Cortisol Random (Enhanced Chemiluminesence)	22.3	ug/dl

BIOCHEMISTRY

Test	Result	Unit	Biological Reference Interval
Serum Cortisol (8 Am) (Enhanced Chemiluminesence)	13.5	ug/dl	4.46-22.7

Interpretation Notes

- Circulating cortisol levels follow a diurnal pattern in healthy individuals. Levels are highest in the morning after waking and lowest in the evening. Increased levels are seen in Cushings Syndrome, Ectopic ACTH syndrome, Ectopic CRH syndrome, Adrenal adenoma / carcinoma, Adrenal micronodular dysplasia, Adrenal macronodular hyperplasia, Stress. Decreased Levels - Addisons disease, Pituitary dysfunction
  Note: Heterophilic antibodies in human serum can react with reagent immunoglobulins, interfering with in vitro immunoassays. Patients routinely exposed to animals or to animal serum products can be prone to this interference and anomalous values may be observed.

SEROLOGY

Test	Result	Unit	Biological Reference Interval
CRP (C -Reactive Protein) (Quantitative Immuno-turbidimetric Assay)	**18.436 H**	mg/L	Negative: < 5 Positive: => 5

MICRO BIOLOGY

AFB BACTEC CULTURE

AFB SMEAR

SPECIMEN SOURCE	TISSUE
SMEAR	NOT DETECTED
WEEK3	
CULTURE :WEEK3	NO GROWTH DETECTED AT END OF THIRD WEEK
AFB CULTURE	
AFB CULTURE	NO GROWTH DETECTED AT THE END OF SIXTH WEEK

MOLECULAR LABORATORY

Test	Result	Unit	Biological Reference Interval
GENE XPERT (XPERTMTB/RIF)			
SPECIMEN	TISSUE	-	-
Mycobacterium Tuberculosis (Cartridge Based Nucleic Acid Amplification)	Not Detected	-	Not detected

HISTOPATHOLOGY

REGULAR HP SMALL SPECIMEN

CASE No.	H-11272/23
CLINICAL DETAILS	C/O bicytopenia splenomegaly LT Adrenal mass. Referral for CT guided biopsy from left adrenal mass Clinical diagnosis : Malignancy.
SPECIMEN DETAILS	CT guided biopsy from left adrenal mass
GROSS EXAMINATION	Received two linear cores measuring 2.0 cm and 1.9 cm in length. Entire tissue processed one capsule. Grossed by Dr. Nisheena. R
MICROSCOPIC EXAMINATION	Section studied show cores of adrenal tissue with sheets of histiocytes with few ill-defined granuloma formation composed of epithelioid histiocytes, foamy histiocytes and multinucleated giant cells with scattered lymphocytes. Large areas of necrosis seen. **Numerous small uniform oval, narrow based budding yeasts clustered within histiocytes (intracellular) morphologically resembling histoplasma capsulatum.** The GMS and PAS stains highlights and confirms the presence of fungal organisms. The ZN stain is negative for acid fast bacilli. No evidence of malignancy seen.
IMPRESSION	**Fungal infection - Histoplasma organisms , adrenal lesion.**

Patient was given

- ITRACONAZOLE-CAPSULE-200MG
- Hydrocortisone after ACTH stimulation test

Assessment:

Imaging:

- USG
- CT
- MRI
- FDG PET

-->If suspecting malignancy

-->False negative PET in necrotic/ hemorrhagic metastases, metastasis from FDG-non-avid tumours like HCC/ mucinous primary.

-->False positive PET in functioning adenomas

- MIBG SPECT (Useful in patients with biochemical evidence of pheochromocytoma but without a mass on CT, nowadays FDG –PET / DOTA scans are more commonly used)

Histopathology

- Core or excision biopsy

Parallel endocrine work-up

- Exclude cortisol excess in all incidentalomas
- Exclude metanephrine level elevation in all incidentalomas-pheochromocytoma
- Aldosterone/renin ratio in hypertensives-Primary hyperaldosteronism
- Sex hormones and steroid precursors in adrenocortical carcinoma
- Bilateral lesions – 17-Hydroxyprogesterone levels- congenital adrenal hyperplasia

CT

- 5 mm section with 1 mm reconstruction
- Unenhanced phase
- Contrast at 3.5 ml / sec followed by saline at 3.0 ml/sec
- Late arterial phase at 15-20 seconds
- Venous phase at 60-80 sec
- Delayed phase at 15 minutes
- For attenuation measurement , the ROI should occupy half to two-thirds of the lesion area (Avoid necrosis and calcification).
- CT = MRI for 10 – 20 HU
- CT > MRI for > 20 HU

Contrast Washout

$$\text{Absolute wash out} = \frac{\text{Enhanced CT (HU)} - \text{Delayed CT (HU)}}{\text{Enhanced CT (HU)} - \text{Unenhanced CT (HU)}} \times 100\%$$

$$\text{Relative wash out} = \frac{\text{Enhanced CT (HU)} - \text{Delayed CT (HU)}}{\text{Enhanced CT (HU)}} \times 100\%$$

Absolute wash out $\geqslant$ 60% = adenoma

Relative wash out $\geqslant$ 40% = adenoma

- Adenomas demonstrate relatively rapid washout
- Pheochromocytomas (30 – 45 % of cases) and hypervascular metastasis (RCC etc) can also demonstrate rapid washout
- Adrenal mass density on CM phase >140 HU suspicious for hypervascular metastasis
- Adrenal mass density on CM phase >110 HU suspicious for Pheochromocytoma

MRI

- Mainly chemical shift imaging (In phase and opposed phase images)
- STIR(*macroscopic)
- T1 (For adrenal anatomy)
- T2 (T2 hyperintense-Pheochromocytoma)
- DWI (Lymphomas - restricted diffusion)
- GRE/MERGE
- Dynamic contrast imaging

Adrenal MRI Calculator

$$\text{Adrenal-to-spleen ratio} = \frac{\text{Lesion SI(op) / spleen SI (op)}}{\text{Lesion SI (ip) / spleen SI (ip)}}$$

$$\text{Signal intensity index} = \frac{\text{Lesion SI (ip) – lesion SI (op)}}{\text{Lesion SI (ip)}} \times 100\%$$

Adrenal-to-spleen ratio <0.71 = adenoma

SI-index > 16,5% = adenoma

GRANULOMATOUS DISEASE:

- Commonly tuberculosis and histoplasmosis
- Necrotic lesions
- Frequently bilateral
- Healed --> Calcifications
- May lead to adrenal insufficiency

HISTOPLASMOSIS:

- Ultrasonography : uniformly hypoechoic to heterogenous echopattern
- Bilateral symmetrical adrenomegaly , well circumscribed
- Multi-cystic with enhancing septae
- Honey-comb appearance
- Necrotic lymph nodes +
- Mild to moderate hepatomegaly with or without splenomegaly

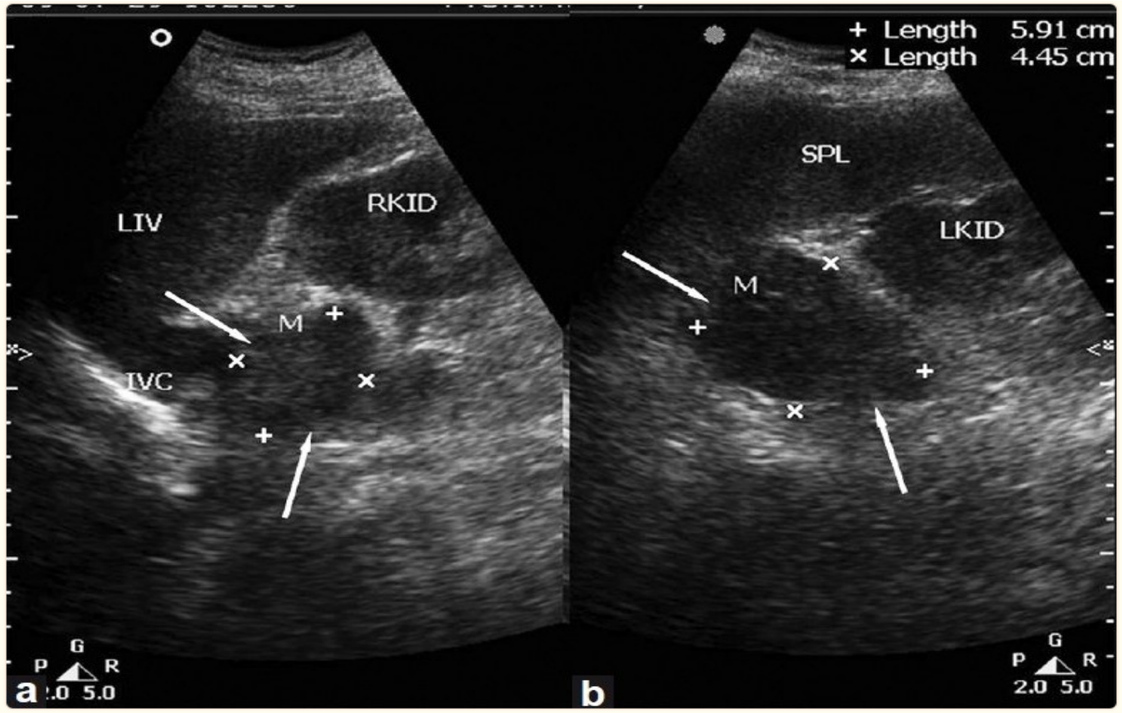


Figure 1

Abdominal ultrasonography showing enlarged, hypoechoic right (a) and left (b) adrenal glands (arrows)

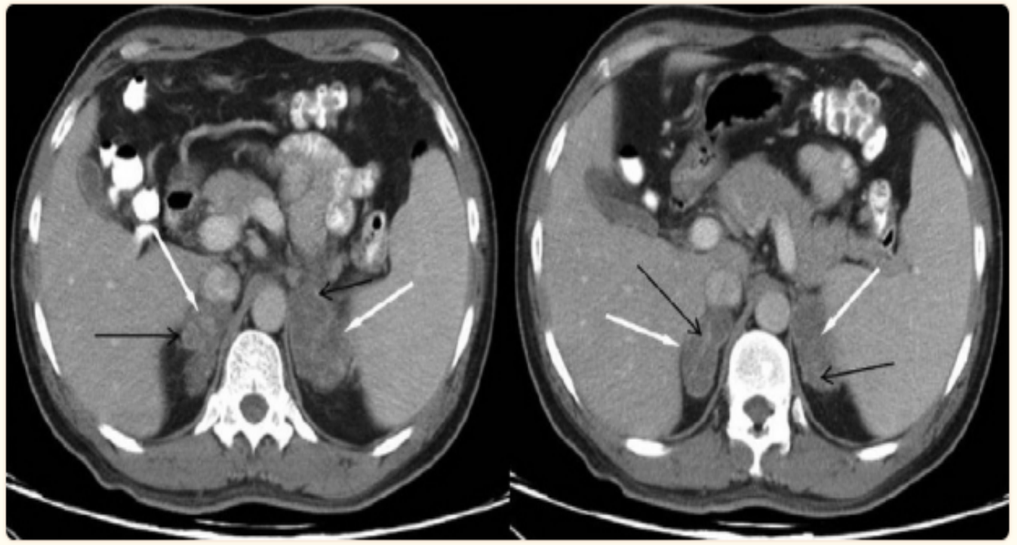


Figure 2

Contrast-enhanced axial CT section of the upper abdomen showing enlarged and hypodense bilateral adrenals (white arrows) with peripheral rim enhancement and enhancing internal septations (black arrows)

ADRENAL TUBERCULOSIS:

Occurs more commonly in bilateral glands than in unilateral gland.

CT

- gland contour:
  - in the early stage there can be mass-like adrenal enlargement
    - smooth adrenal contour is preserved
  - later on adrenal fibrosis and atrophy occurs
    - small adrenals with irregular margins
- calcification:
  - this is a late feature, often occurring post-treatment
- gland density:
  - central low density can be seen in early disease
    - due to caseous necrosis
- Enhancement:
  - can see areas of relative central hypoenhancement

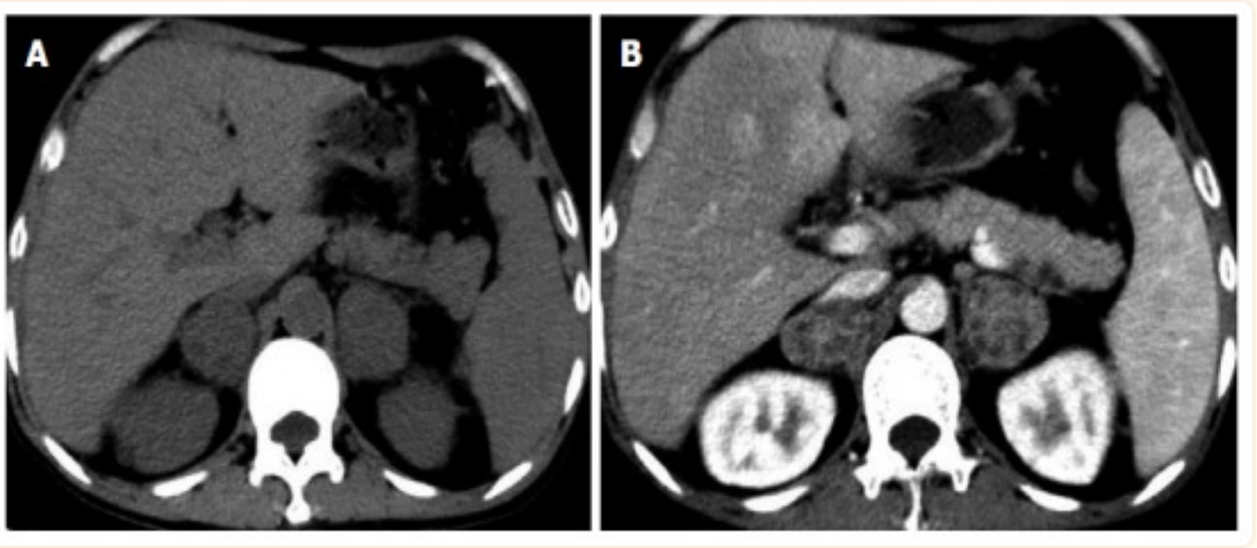
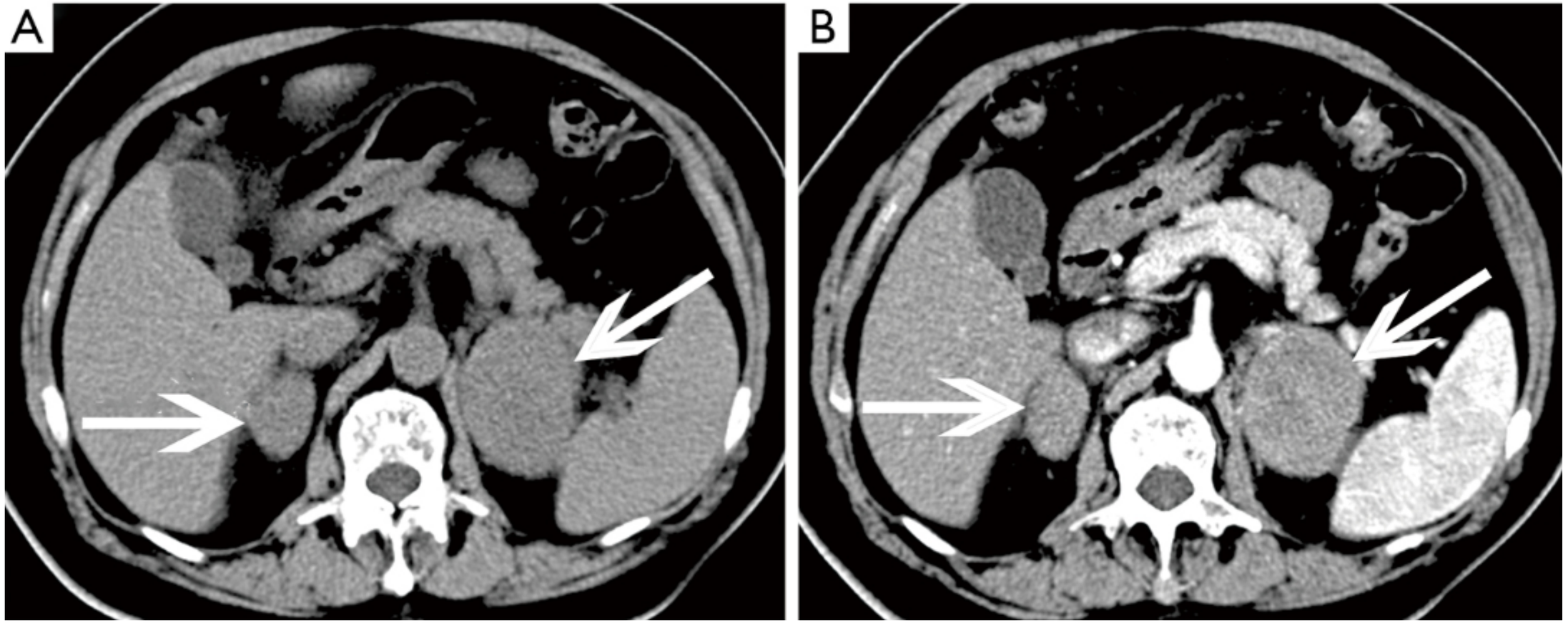


Figure 1

A 53-year-old man who has fatigue, pigmentation of skin and loss weight in last five months with primary adrenal insufficiency due to adrenal tuberculosis. The unenhanced (A) and contrast-enhanced (B) CT scans reveal the mass-like enlargement of the bilateral adrenals with multifocal peripheral enhancement. CT: Computed tomography.

LYMPHOMA:

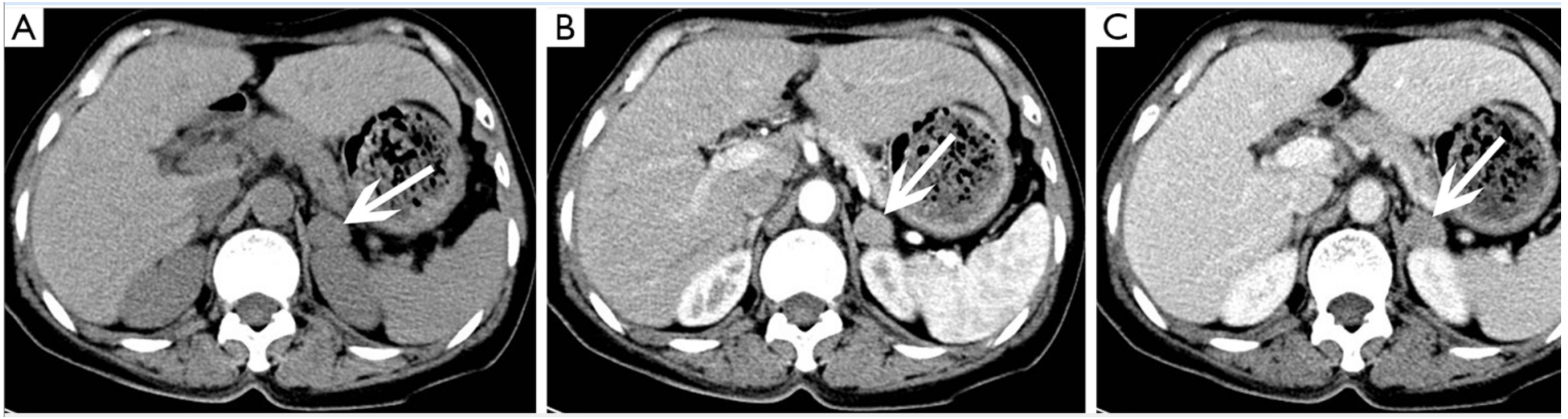
- NHL> Hodgkins
- More common as secondary involvement with extra-adrenal disease than primary
- Homogenously hypoenhancing
- Low on T1, intermediate on T2
- 50 % bilateral
- Restricted diffusivity
- FDG-PT avid



Bilateral adrenal lymphomas in a 76-year-old man. (A) Axial pre-contrast CT scan and (B) contrast-enhanced axial CT scan images show bilateral adrenal round masses (arrows) with CT attenuation value about 35 HU and slightly enhanced

METASTASIS:

- Suspect if known primary
- Lung, breast , GIT , kidney
- Variable homogeneity and margins
- Absolute washout< 60 % and relative washout < 40 %
- No signal drop in CSI (With exceptions)



Metastases in a 59-year-old woman with small cell lung cancer. (A) Axial pre-contrast CT image shows a 21 mm × 17 mm round nodule with CT attenuation value about 41 HU (arrows). (B) Axial arterial and (C) venous phase images show obvious enhancement.

PHEOCHROMOCYTOMA:

- The 10% rule:10% are extra-adrenal , bilateral, malignant , children ,familial
- ASSOCIATIONS: MEN IIa and MEN IIb --> Rarely extra-adrenal, almost always bilateral
- Von Hippel-Lindau disease
- Neurofibromatosis type 1
- Sturge-Weber syndrome
- Clinical presentations: Secondary hypertension / Hypertensive crisis
- Features of cardiac dysfunction or neurological events
- Raised plasma and urine metanephrines
- Local invasion or distant metastasis -->Malignant
- Important to ensure that any adrenal lesion is hormonally inactive before biopsy(Rule out functional pheochromocytoma)

USG

- Variable appearance

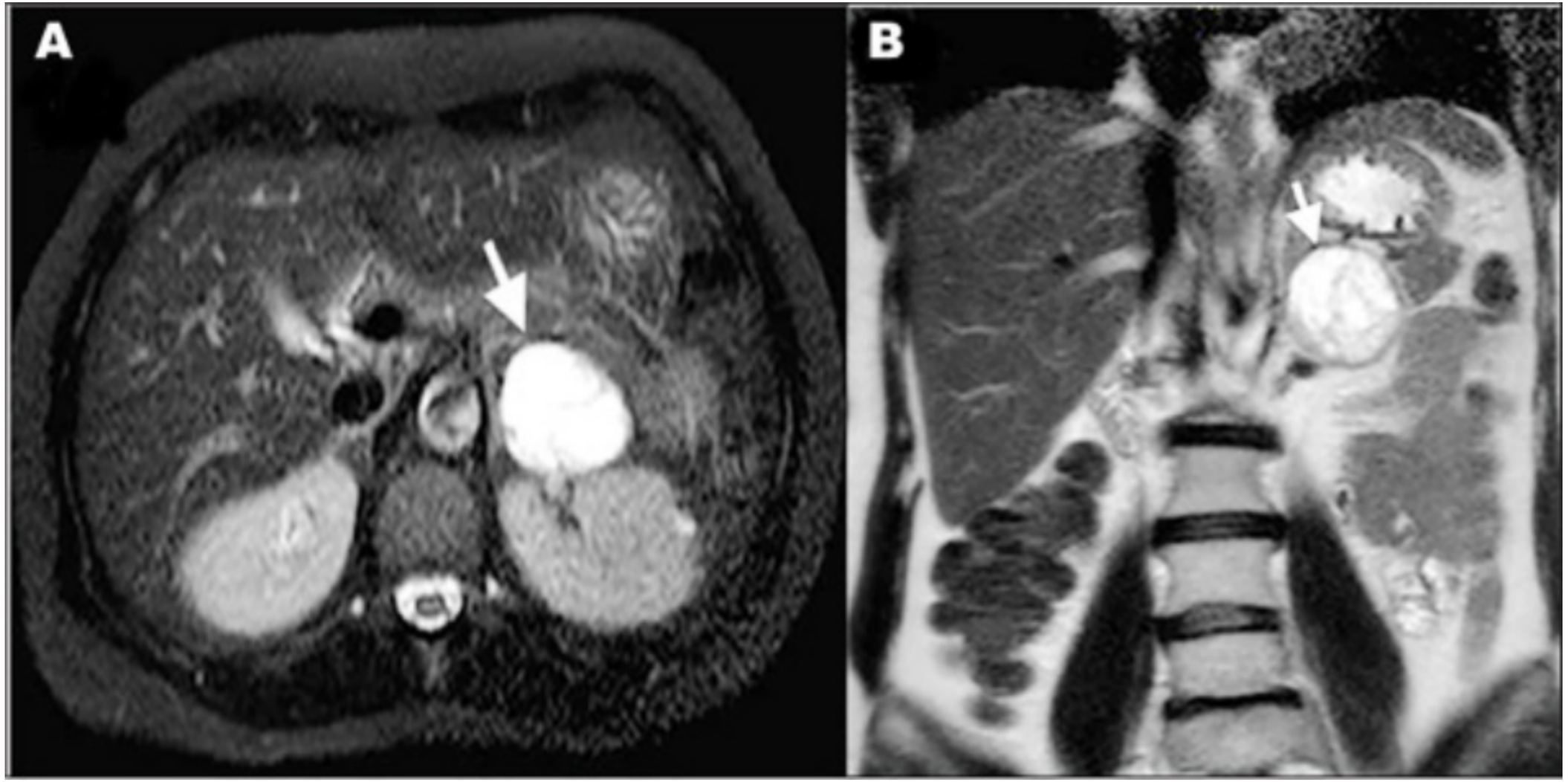
CT

- Heterogenous mass with necrosis/cystic changes.
- Avid enhancement, may wash out similar to an adrenal adenoma, but they tend to have a greater enhancement in an arterial or portal venous contrast phase(>110 HU)

MRI

- T1 :slightly hypointense, heterogeneous if necrotic/hemorrhagic
- Markedly T2 hyperintense(Light bulb sign).
- No signal loss on out of phase imaging
- Heterogenous and prolonged contrast enhancement

- Light bulb sign (T2w MR)



ADRENAL CORTICAL HYPERPLASIA:

- Can present as cushing's , conn's
- ACTH dependent/ independent
- Nodularity with maintained adreniform pattern

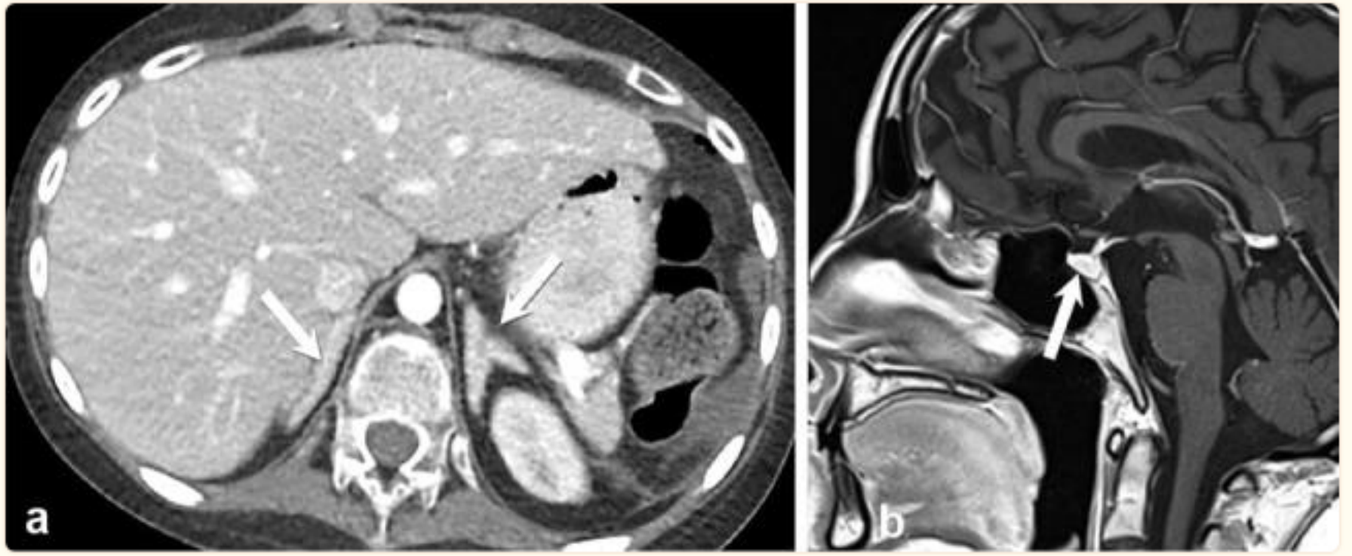
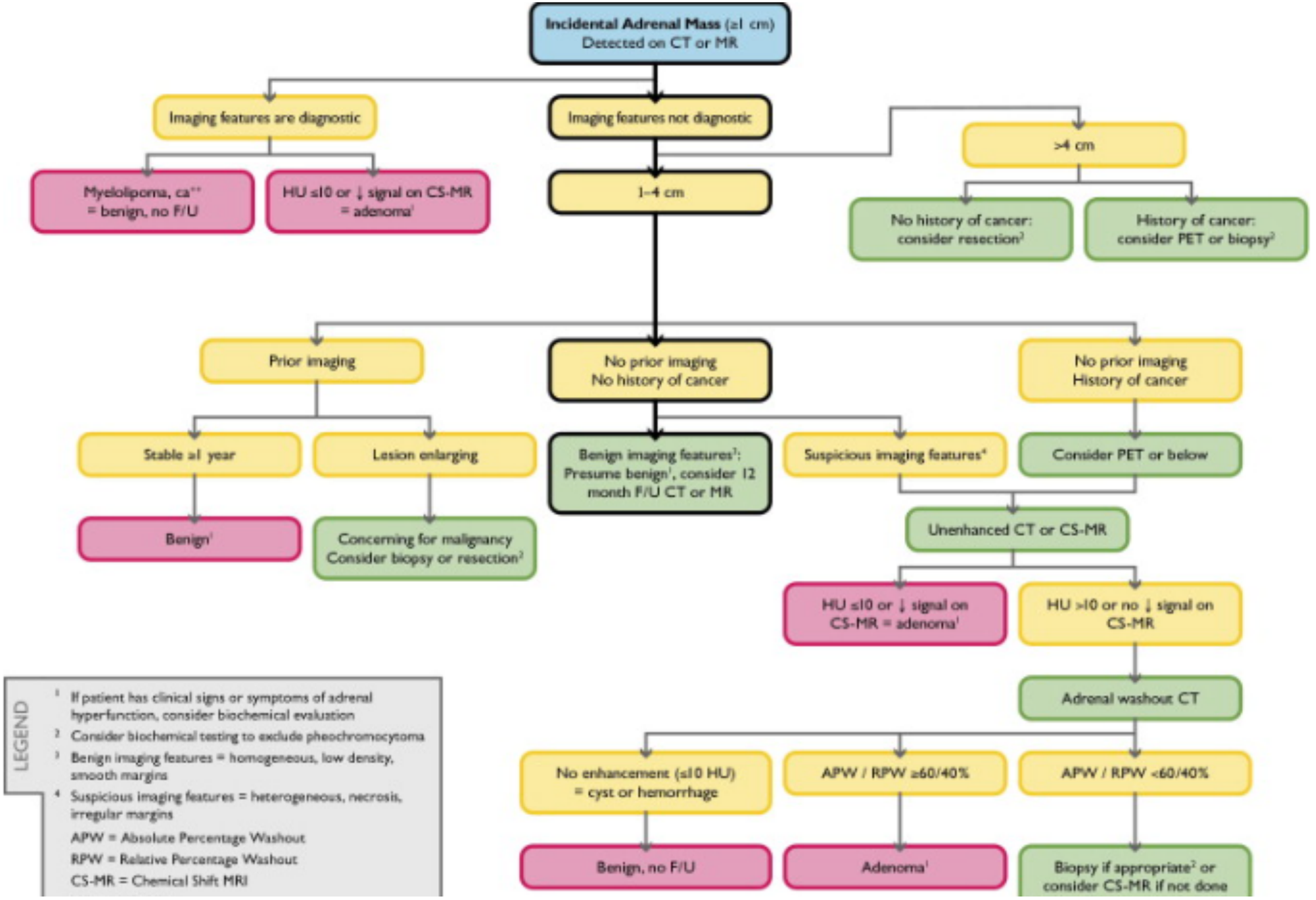


Figure 2.

Cushing disease in a 13-year-old female with 3-month history of worsening acne, hirsutism, fatigue, headache and muscle weakness. Contrast-enhanced axial CT image (a) shows bilateral hypertrophied adrenal glands (arrows). Sagittal T_1 weighted image of the brain demonstrates a normal-appearing pituitary gland (arrow) (b).

ADRENAL HEMATOMAS:

- Bilateral adrenal hematomas can result in fatal adrenal insufficiency
- Irregular hemorrhage obliterating the adrenal gland
- Periadrenal hemorrhage / fat stranding
- Acute hematomas show high attenuation on non-contrast CT
- Attenuation and hematoma decrease over time
- Calcifications may be present in previous H/o hematomas
- Uniform adrenal swelling with increased attenuation


Incidental Adrenal Mass (≥1 cm)
Detected on CT or MR
Imaging features are diagnostic
Imaging features not diagnostic
Myelolipoma, ca**
= benign, no F/U
HU ≤10 or ↓ signal on CS-MR
= adenoma[1]
1–4 cm
>4 cm
No history of cancer:
consider resection[2]
History of cancer:
consider PET or biopsy[2]
Prior imaging
No prior imaging
No history of cancer
No prior imaging
History of cancer
Stable ≥1 year
Lesion enlarging
Benign imaging features[3]:
Presume benign[1], consider 12
month F/U CT or MR
Suspicious imaging features[4]
Consider PET or below
Benign[1]
Concerning for malignancy
Consider biopsy or resection[2]
Unenhanced CT or CS-MR
HU ≤10 or ↓ signal on
CS-MR = adenoma[1]
HU >10 or no ↓ signal on
CS-MR
Adrenal washout CT
No enhancement (≤10 HU)
= cyst or hemorrhage
APW / RPW ≥60/40%
APW / RPW <60/40%
Benign, no F/U
Adenoma[1]
Biopsy if appropriate[2] or
consider CS-MR if not done
LEGEND
1 If patient has clinical signs or symptoms of adrenal hyperfunction, consider biochemical evaluation
2 Consider biochemical testing to exclude pheochromocytoma
3 Benign imaging features = homogeneous, low density, smooth margins
4 Suspicious imaging features = heterogeneous, necrosis, irregular margins
APW = Absolute Percentage Washout
RPW = Relative Percentage Washout
CS-MR = Chemical Shift MRI