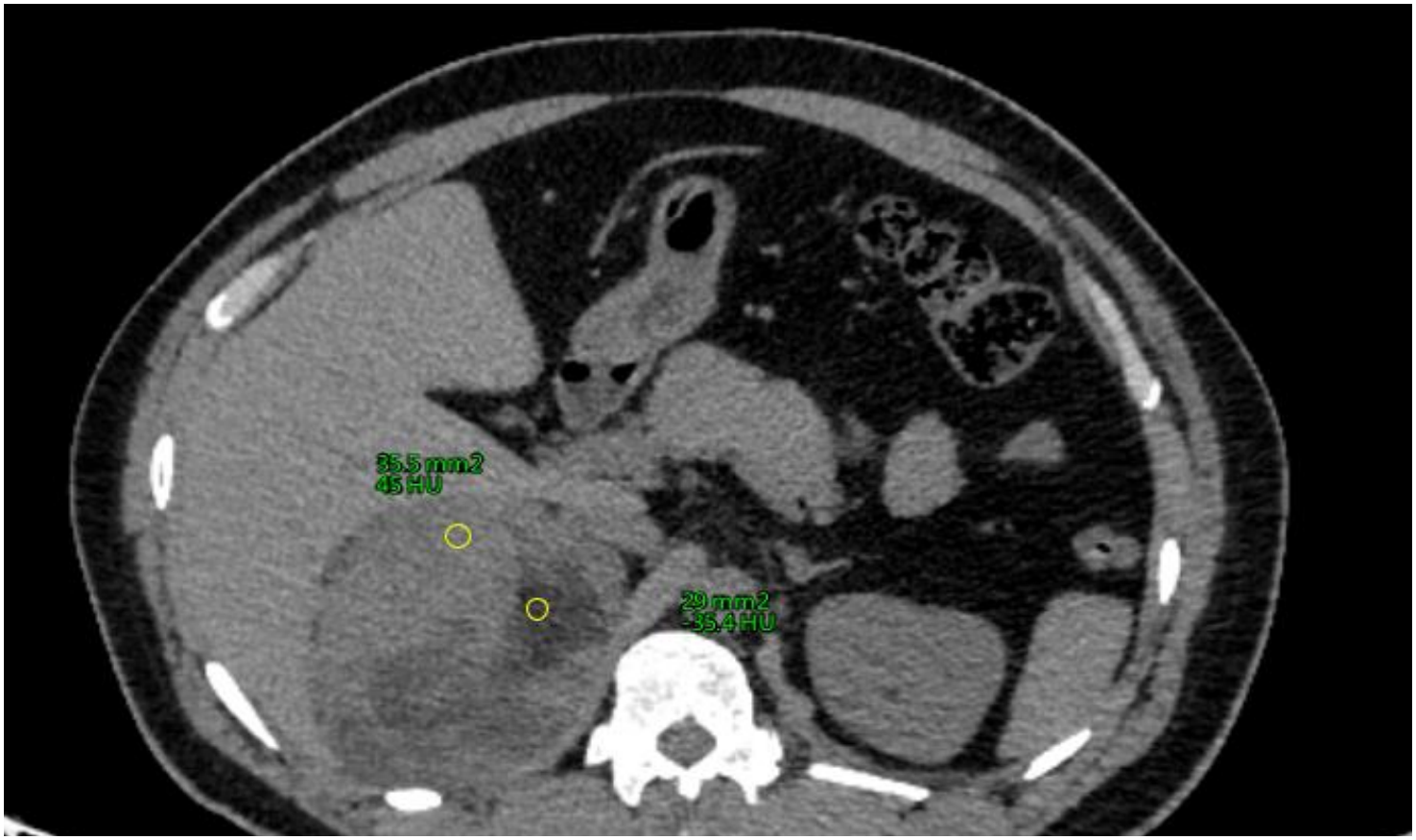
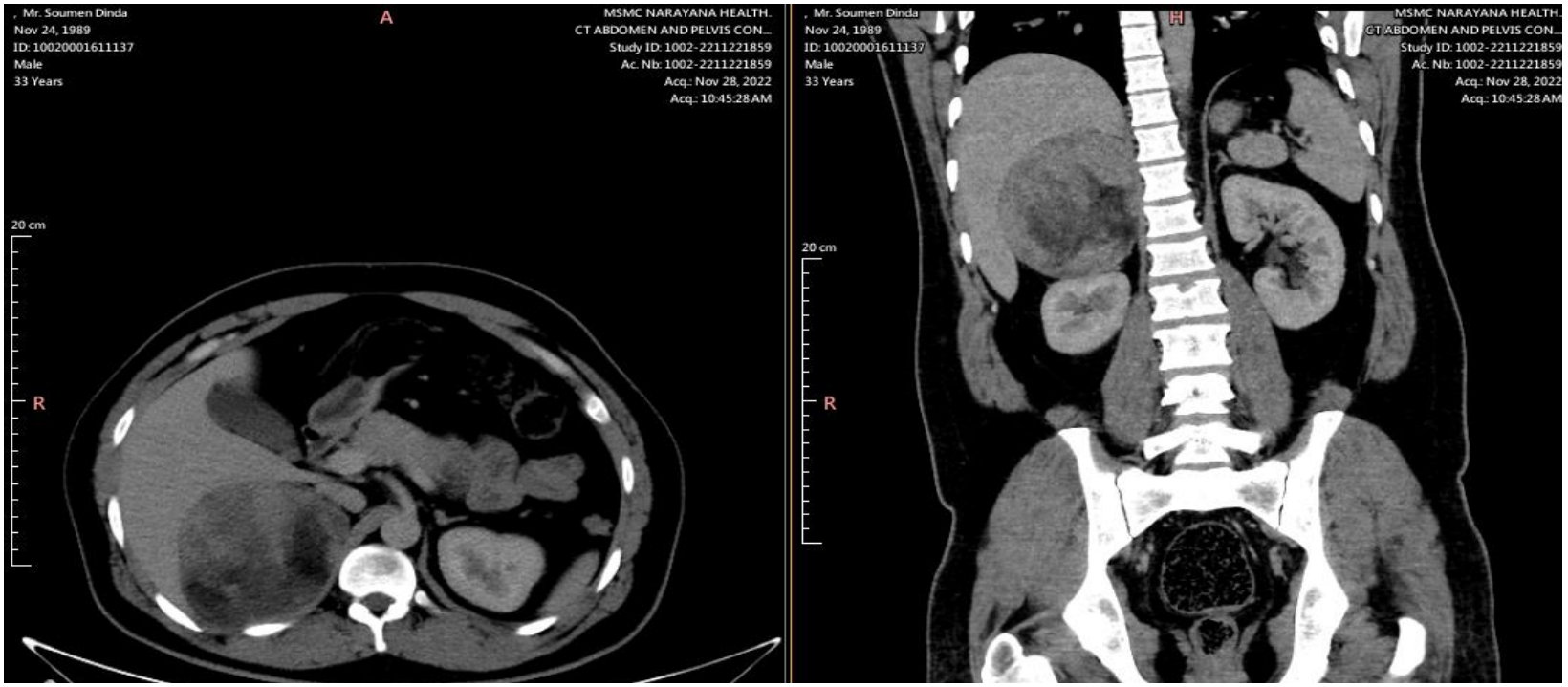
2025

KARNATAKA RADIOLOGY EDUCATION PROGRAM

- Large well defined round mixed attenuation lesion with fat and soft tissue components in right adrenal gland.
- Soft tissue component shows homogenous enhancement.
- No e/o of calcifications / haemorrhage.



- Lesion is abutting the following stx:
- Superiorly abutting segment V and VI of liver
- Inferiorly abutting upper pole of right kidney and causing infero-medial displacement of right kidney.
- Anteriorly abutting infrahepatic IVC and causing mild luminal compression.
- Loss of fat plane with adjacent stx but no e/o infiltration.



- Based on imaging findings diagnosis of **adrenal angiomyolipoma** was given.

Management

- Patient was advised yearly follow up with USG.
- On follow up USG there was increase in size from 10 cm to 12 cm.
- Patient was advised surgery.
- Patient is waiting for surgery.

DISCUSSION

Anatomy:

Max width of adrenal glands, measured perpendicular to long axis of body:

- Right: 6.1 mm
- Left: 7.9 mm

Grossly it should be thinner than adjacent diaphragmatic crura

Size is larger in < 1 yr age

- Adrenal gland has outer cortex & inner medulla.
- Adrenal cortex:

90% of AG, derived from from mesoderm, has 3 zones

- Adrenal medulla:

10% of AG, derived from ectoderm

	Secretions	Excess	Deficiency
Zona Glomerulosa (outer)	Mineralocorticoid (Aldosterone)	Conn's s/d	Addison's d/s
Zona Fasciculata (middle)	Glucocorticoid (Cortisol)	Cushing's s/d	Addison's d/s
Zona Reticularis (inner)	Androgen	Androgenital s/d	Adrogen deficiency
Adrenal medullla	Adrenaline,	Pheochromocytoma	

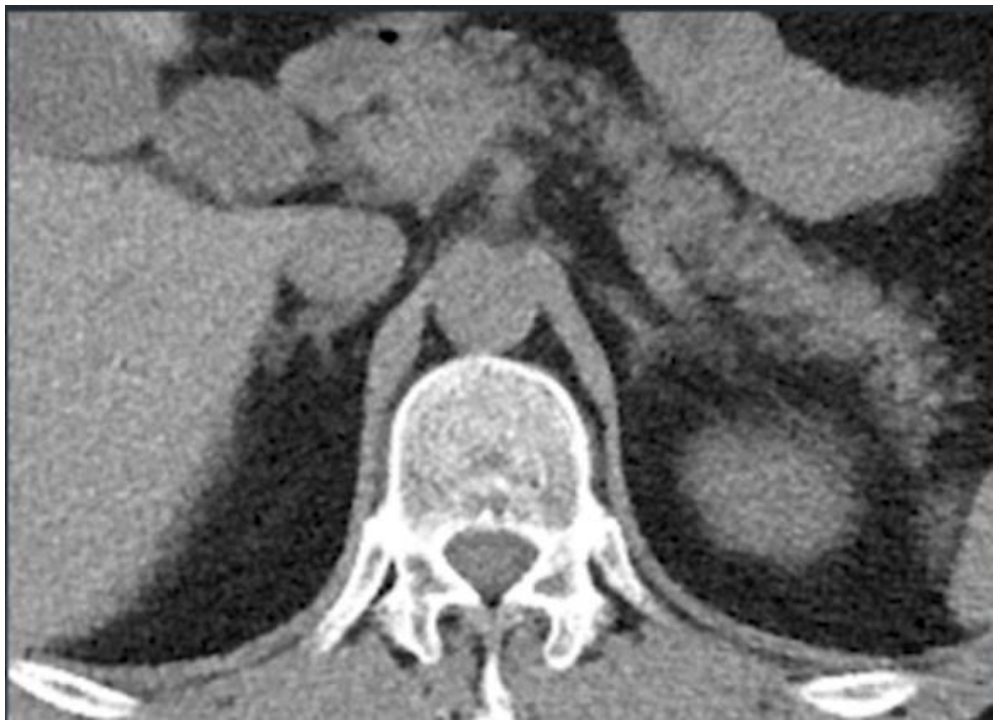
CT Adrenal Protocol

- If no nodule: no contrast required
- If nodule +

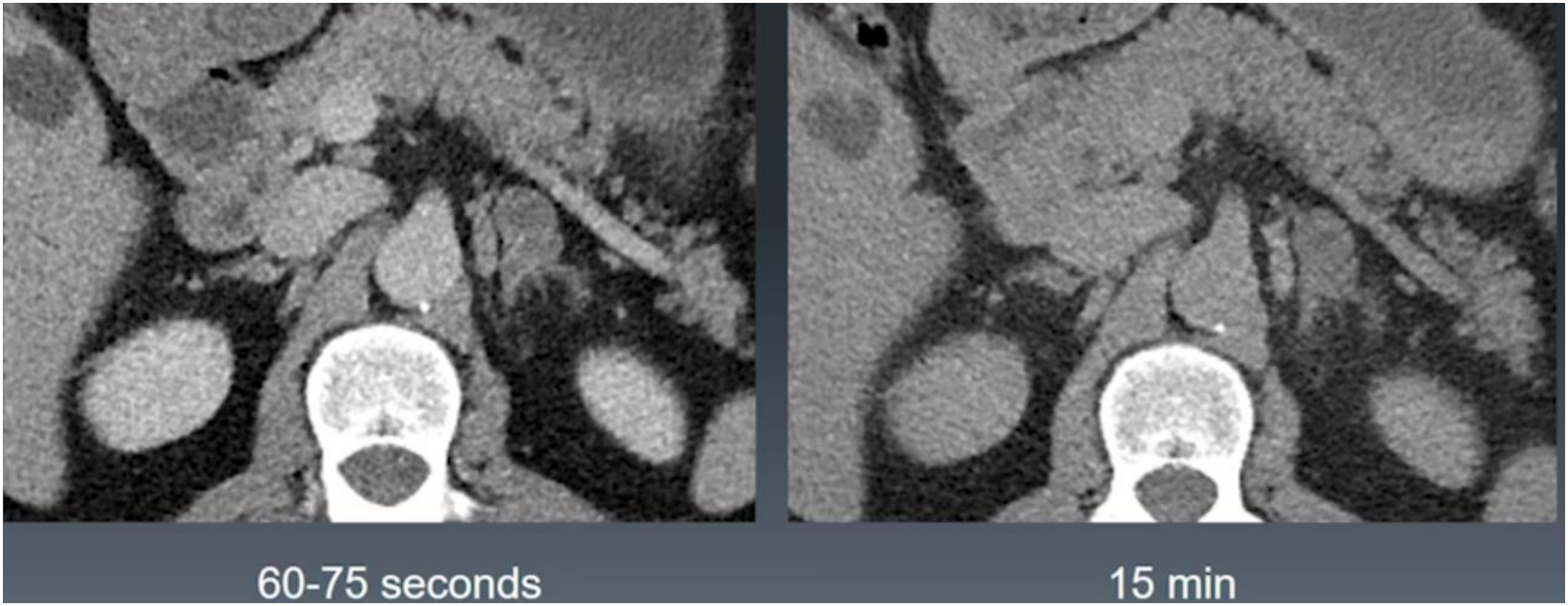
<10 HU: no contrast required

>10 HU: contrast is required

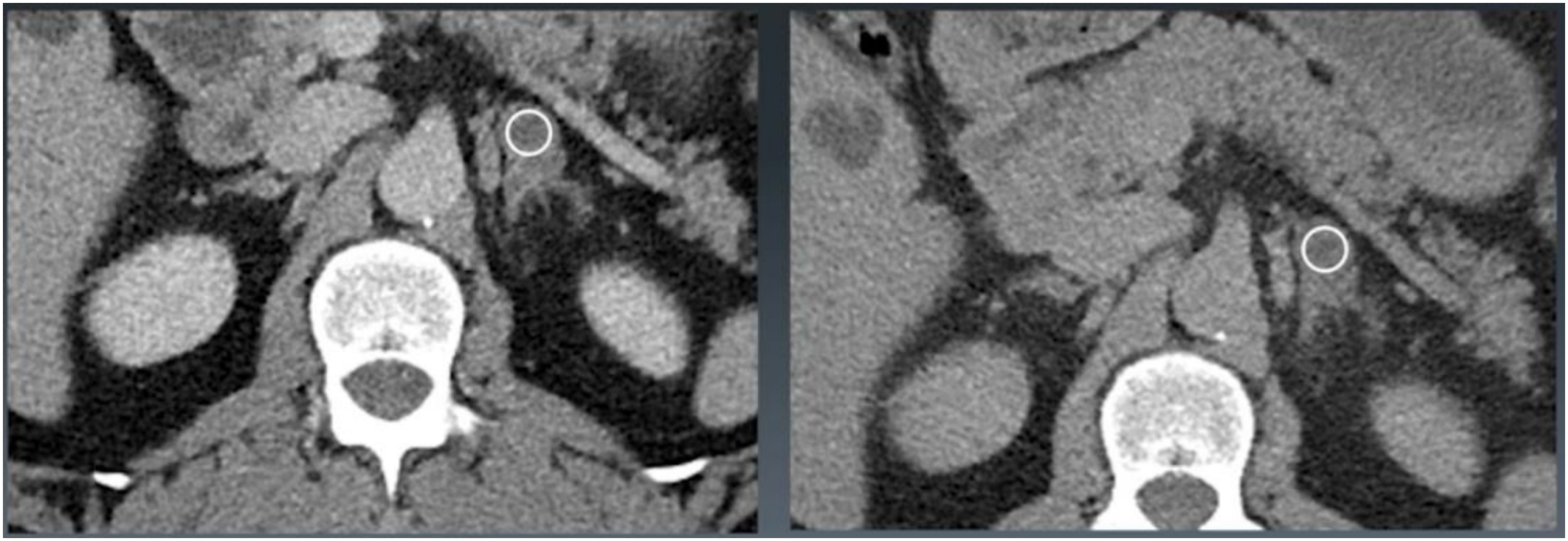
ROI is placed in thin sections



- IV contrast administered and imaging done at 60-75 sec & 15 min
- Allows calculations for absolute & relative washout



- ROI is placed in thin sections.
- Should cover upto 2/3 rd of nodule.
- Should not be placed in necrosis



Attenuation mesurement

- Absolute Washout = $100 \times \frac{\text{Post HU} - \text{Delayed HU}}{\text{Post HU} - \text{Pre HU}}$
- Relative Washout = $100 \times \frac{\text{Post HU} - \text{Delayed HU}}{\text{Post HU}}$

Post = 60-75 sec
Delayed = 15 min

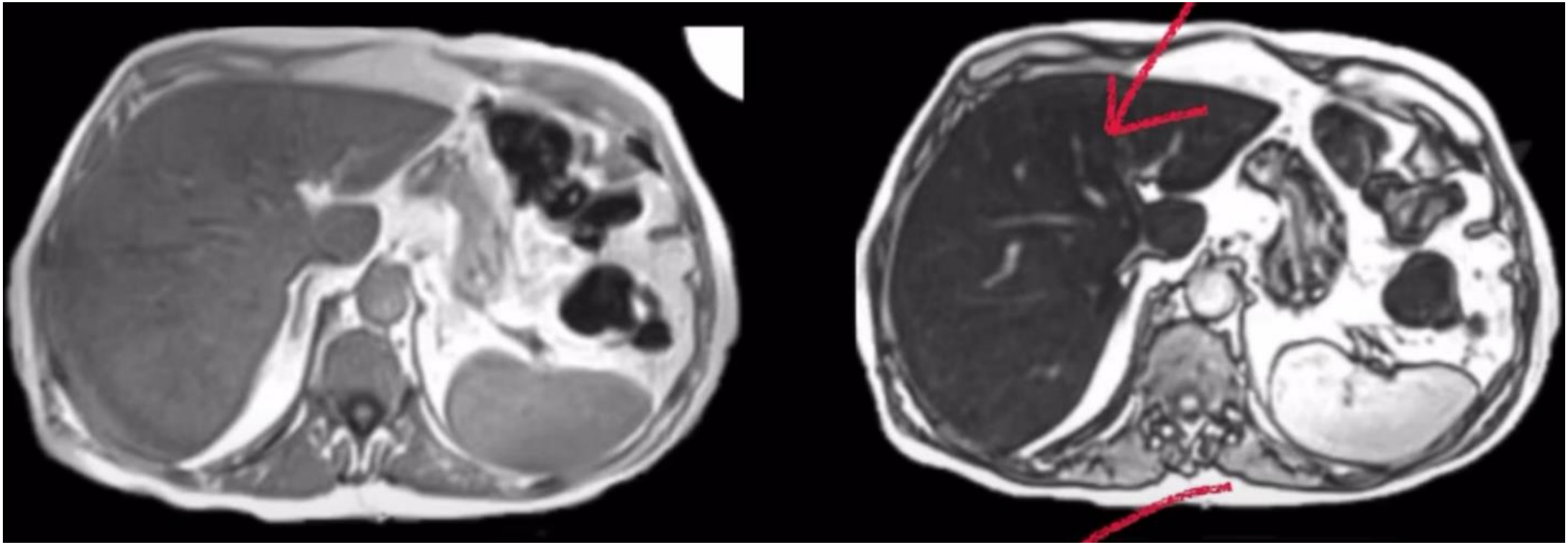
MR Protocol

- T1, T2, T2 FS, IP & OOP
- H+ in water and fat; more signal is given by H+ in water than fat
- IP images are acquired when H+ in water and fat are spinning in same direction; i.e water + fat, more signal
- OOP images are acquired when H+ in water and fat are spinning in opposite direction; water – fat, less signal
- Used to see microscopic fat (cannot be seen): fatty liver, fat in adrenal lesions, HCC, RCC, hepatic adenoma
- Not used to see macrosopic fat (can be seen), here T2 FS is used
- The tissue should contain both water & fat, only then a drop in signal is seen; in s/c tissue only fat is present hence no drop in signal

Fatty Liver

- IN PHASE

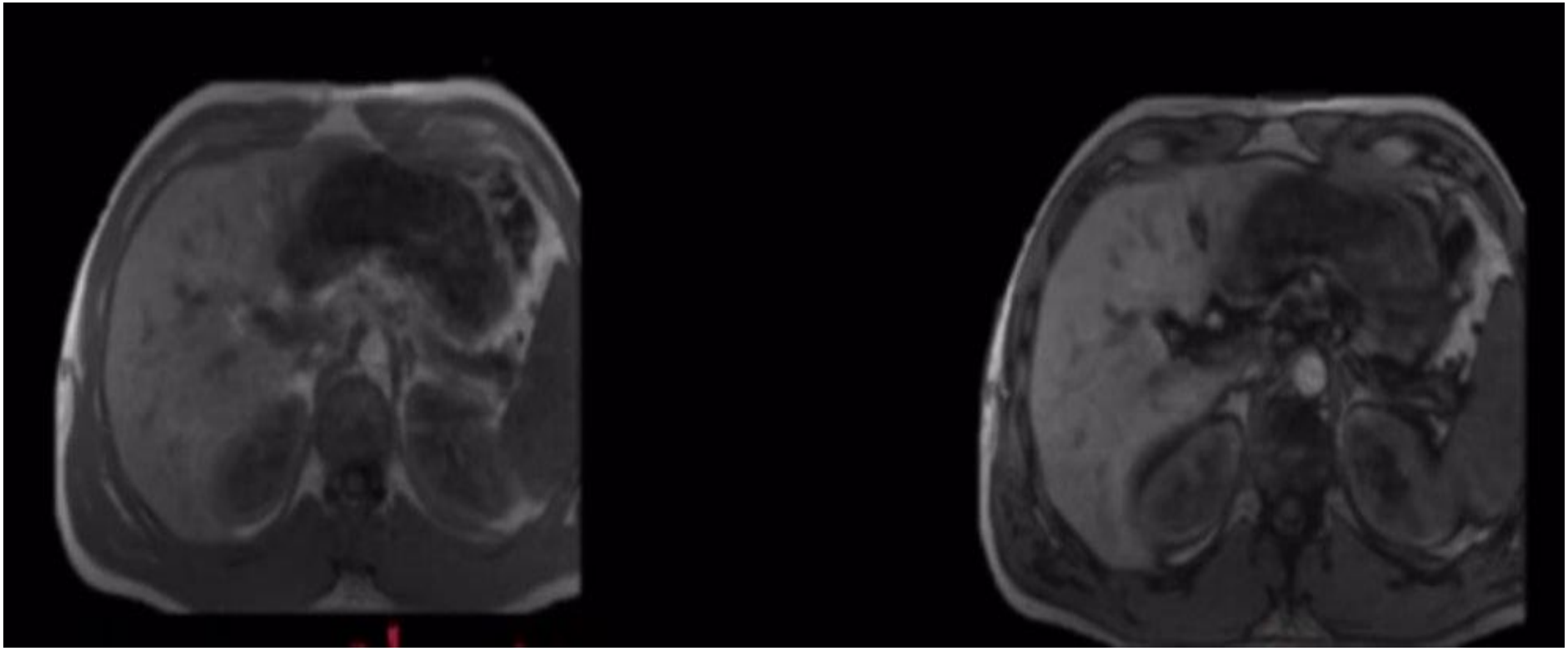
OUT OF PHASE



NORMAL LIVER

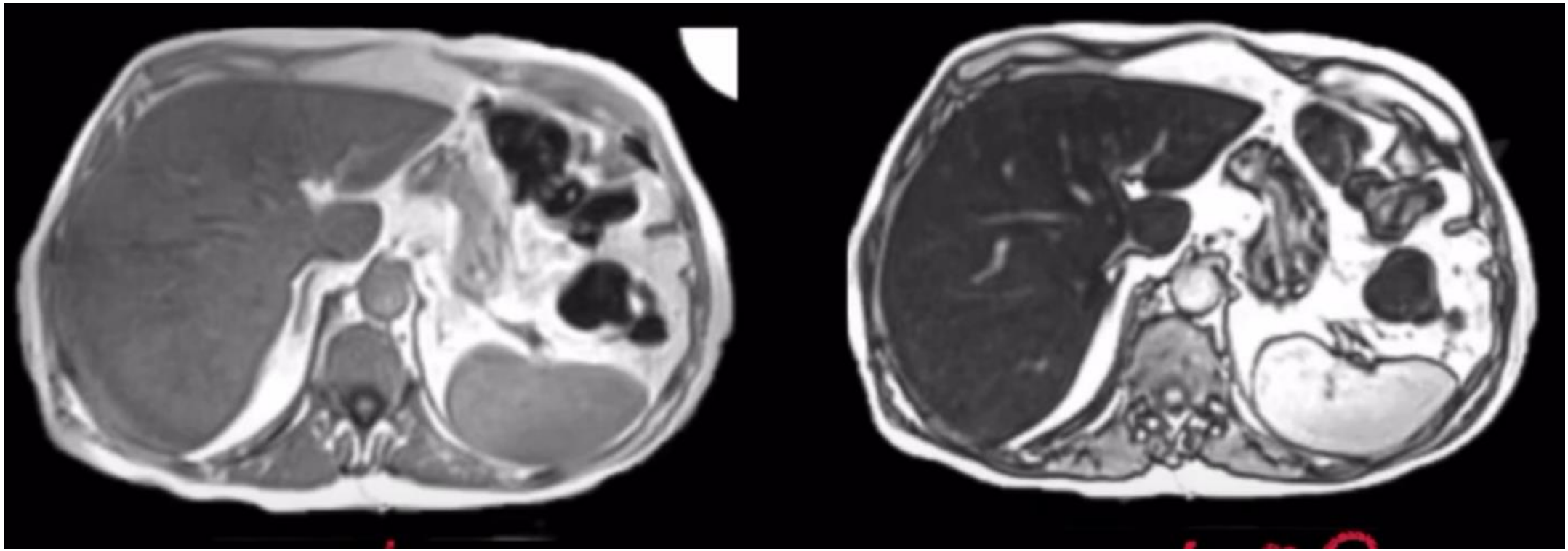
- IN PHASE

OUT OF PHASE



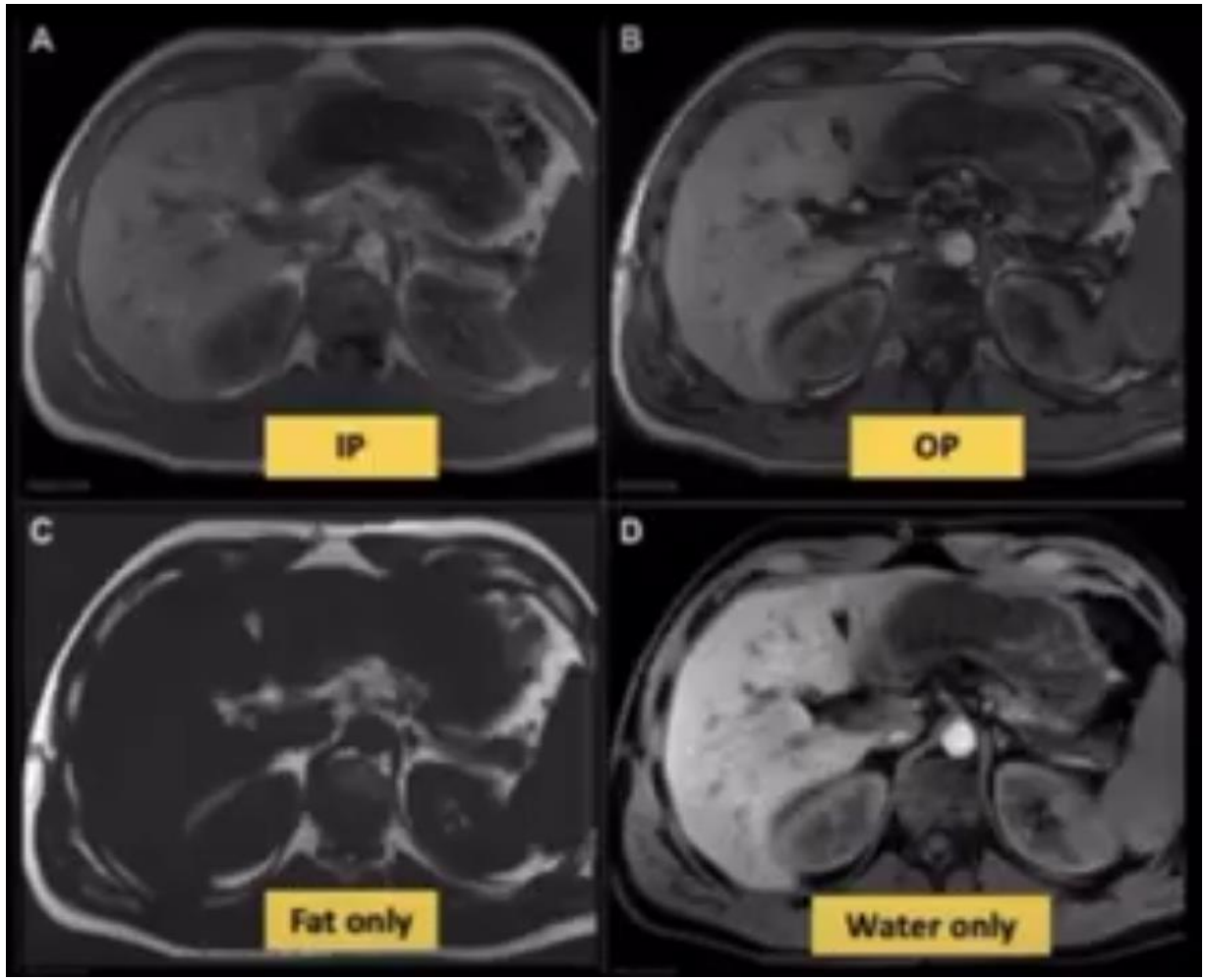
Identify IP & OOP

- OOP images contains arterfactual black line surrounding visceral organs called Indian ink artefact



DIXON Sequences

- IP
- OOP
- Water only = same as T2 FS
- Fat only



Adrenal Pathology

1. Adrenal adenomas

Most common adrenal tumour

5-10% functional secretes cortisol > aldosterone

Imaging features:

1. Size < 4 cm
2. Well defined, homogenous appearance
3. Microscopic fat

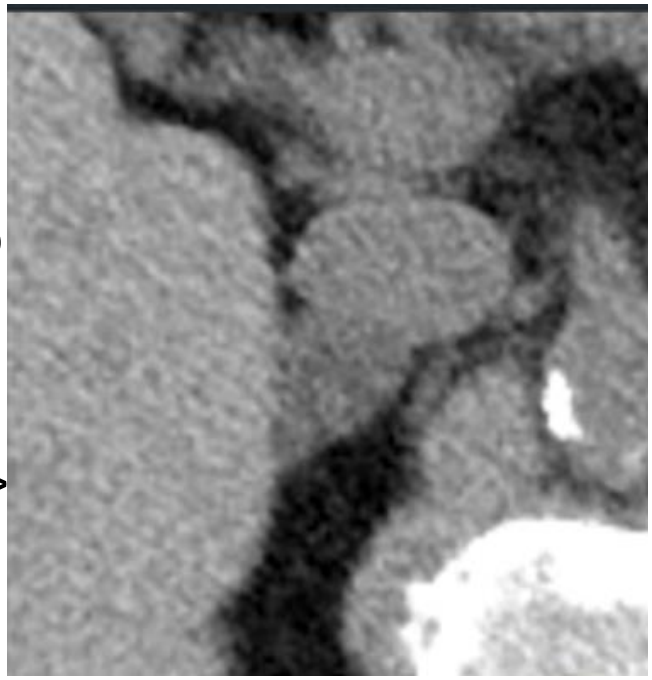
- In NCCT abdomen:

If < 10 HU: lipid rich adrenal adenoma (2/3rd of cases)

If > 10 HU: lipid poor adrenal adenoma (1/3rd of cases)

CECT abdomen adrenal protocol is done

- Rapid washout of IV contrast is seen
- Absolute washout > 60% and relative washout > 40%



Dual energy CT done at 80 & 140 kVp shows difference > 6 HU: suggestive of fat content

PET-CT: no uptake

- MR Imaging features

T2: Hypointense / iso intense

DWI: no diffusion restiction

Loss in signal in OOP: adrenal adenoma

Better sensitive than CT

Subjective assessment is commonly done

Quantitatively by chemical shift ratio (CSI ratio) & signal intensity

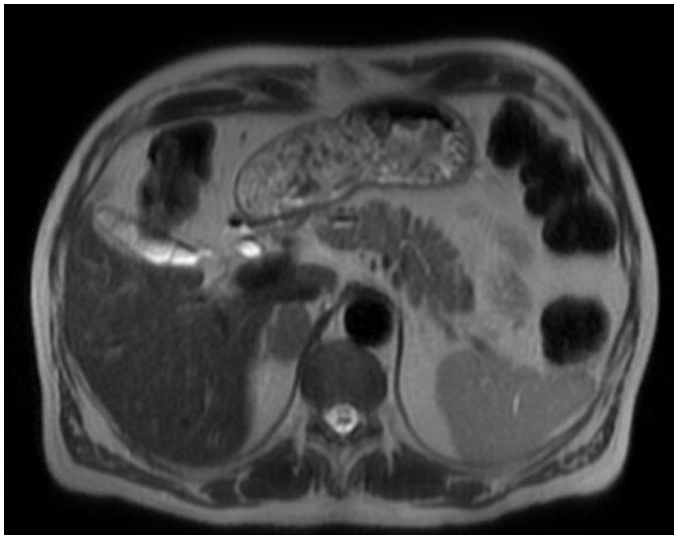
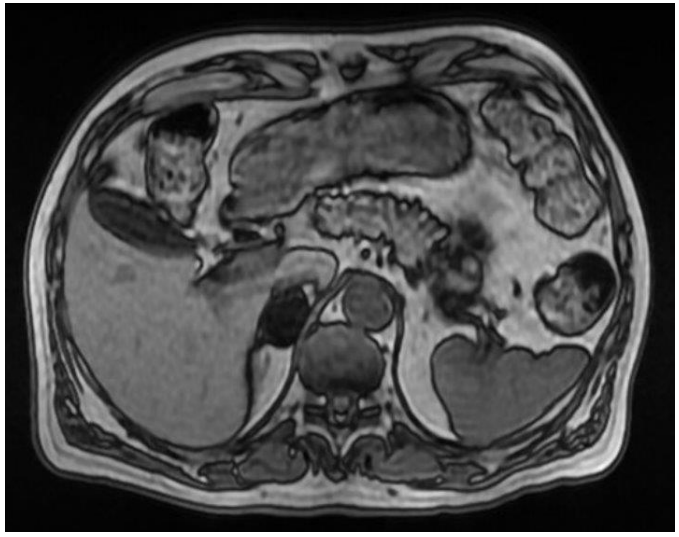
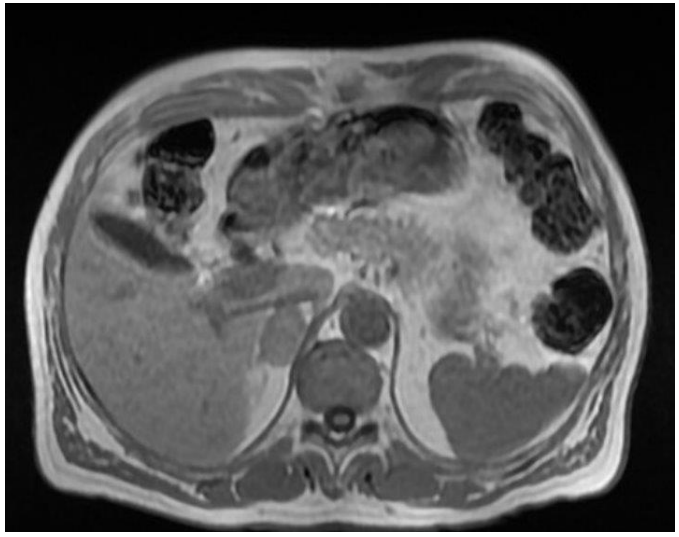
$$\text{CSI ratio} = \frac{\text{lesion SI OP/spleen SI OP}}{\text{lesion SI IP/spleen SI IP}} \quad < 0.71$$

$$\text{SI index} = 100 \times \frac{\text{lesion SI IP} - \text{lesion SI OP}}{\text{lesion SI IP}} \quad > 16.5\%$$

Newer method of analyzing fat in adrenal adenomas is through Pixel mapping histogram analysis

Only NCCT is required

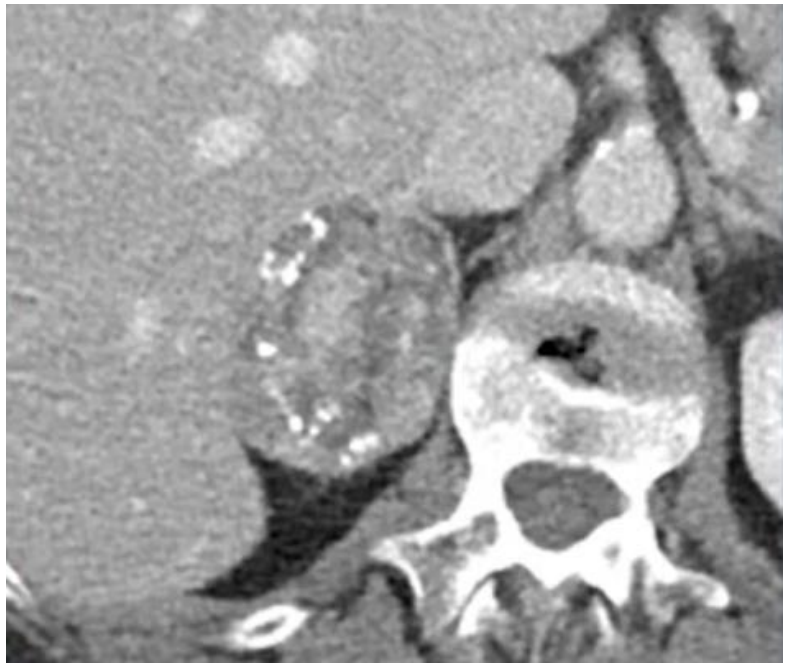
Studies have shown it superior to CT attenuation analysis

2. Atypical adrenal adenomas

Imaging features-

1. Heterogenous appearance: Cystic components, Calcifications, Hemorrhages, Necrosis
2. Macroscopic fat: focal areas of gross fat are seen



- Atypical imaging features should raise suspicion of malignancy.

- If RF are absent, it may be benign due to high prevalence of adrenal adenomas.

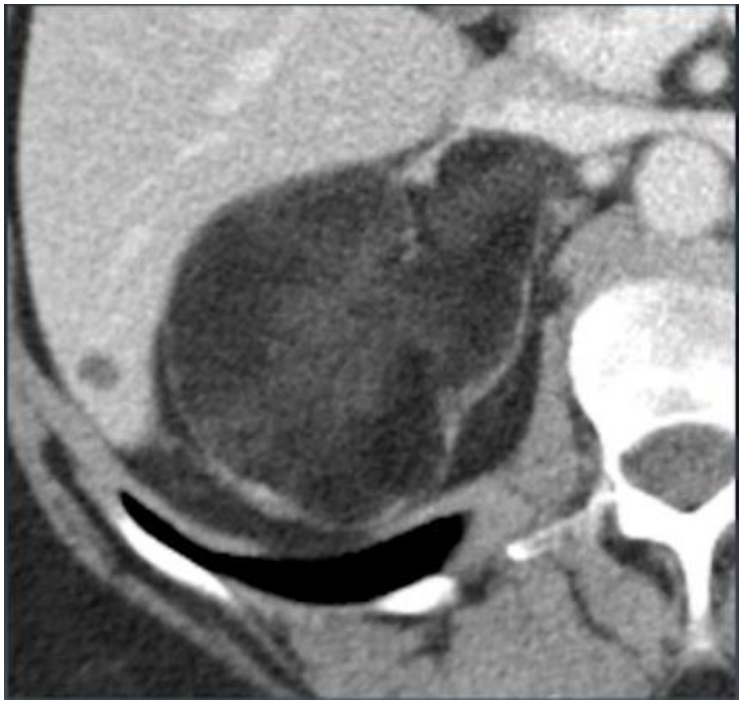
3. Adrenal myelolipoma

Benign tumour composed of fat and hematopoietic tissue

6% of adrenal incidentalomas

Non functional, asyptomatic unless mass effect

Rarely haemorrhage



Imaging features:

1. Macroscopic fat (> 50% is diagnostic)
2. Variables amounts of soft tissue density
3. May calcify

4. Adrenal pheochromocytoma:

NET arising from chromaffin cells

Imaging features: (aka Imaging chameleon due to wide variety of appearance)

CT:

1. Heterogenous appearance (cystic components, calcifications, necrosis)
2. Post contrast enhancement (arterial phase > 100 HU; portal venous phase > 130 HU)
3. 1/3rd of cases shows washout (Absolute washout > 60% and relative washout > 40%)
4. Very rarely may contain macroscopic / microscopic fat.

MRI:

T2 hyperintense (Light bulb sign); may not be always seen

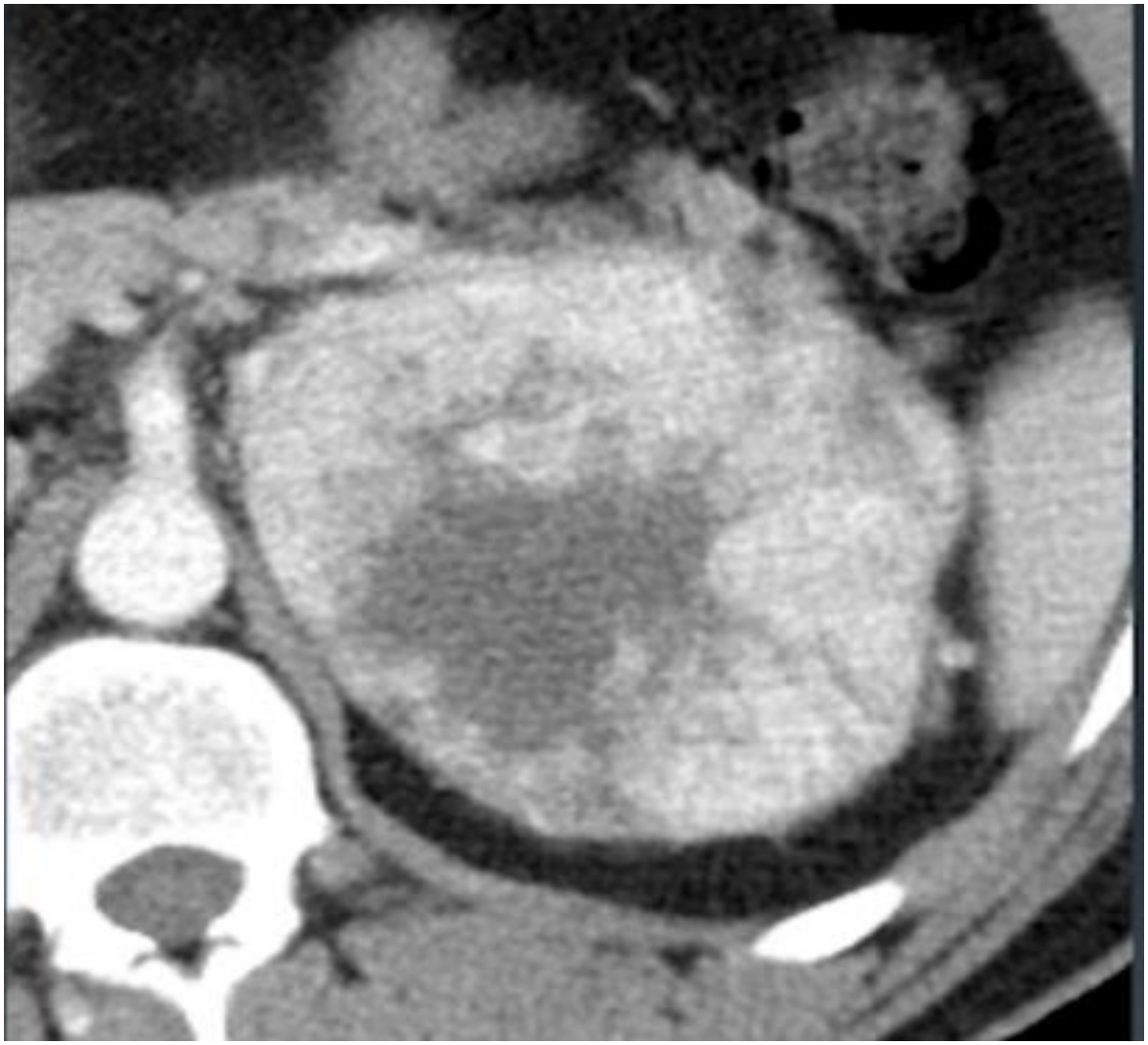
Pheochromocytoma

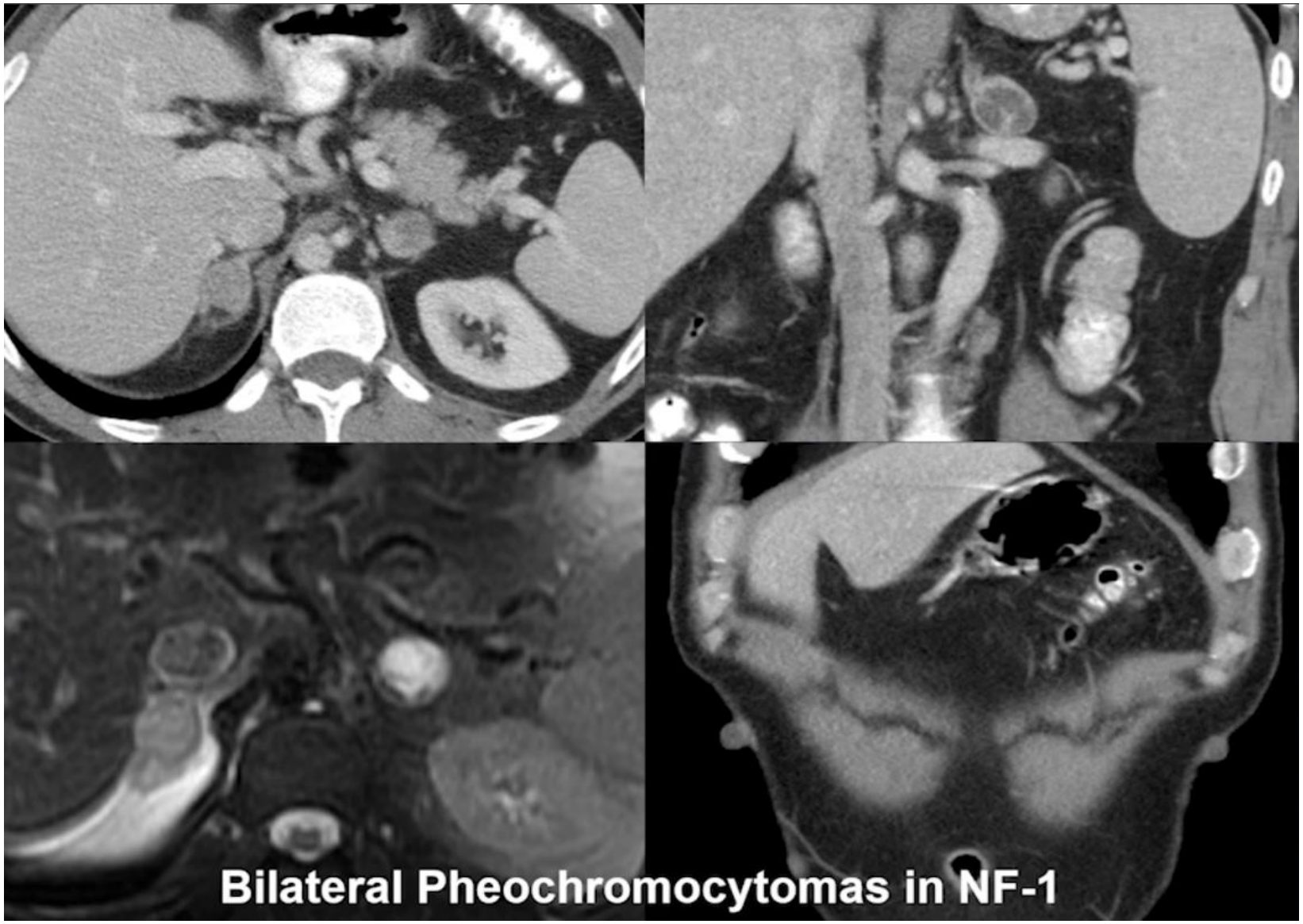
10% tumor

- 10% are extra adrenal
- 10% are bilateral
- 10% are malignant
- 10% are found in children
- 10% are familial
- 10% are not associated with HTN
- 10% contain calcifications

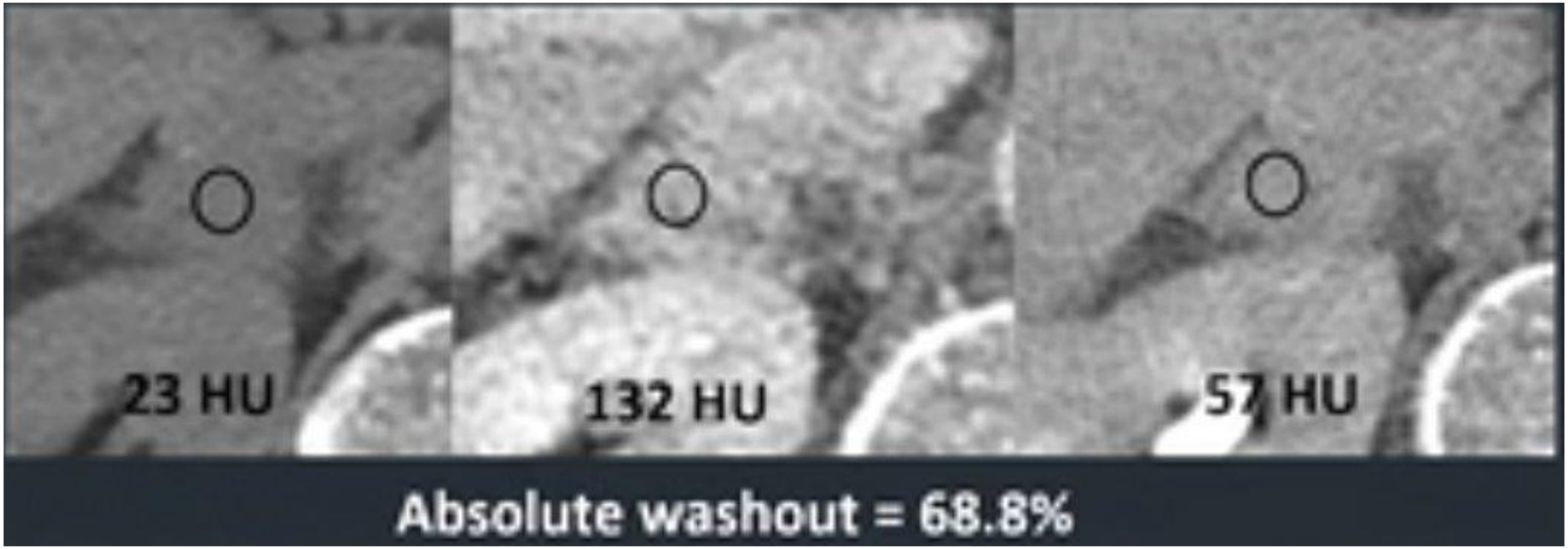
Syndromes a/w pheochromocytoma:

1. Von-Hippel-Lindau s/d
2. NF type 1
3. MEN type 2




Bilateral Pheochromocytomas in NF-1

- 1/3 rd of cases can show washout
- If arterial enhancement > 100 HU; portal venous enhancement > 130 HU; consider pheochromocytoma



5. Adrenal cortical CA

Rare

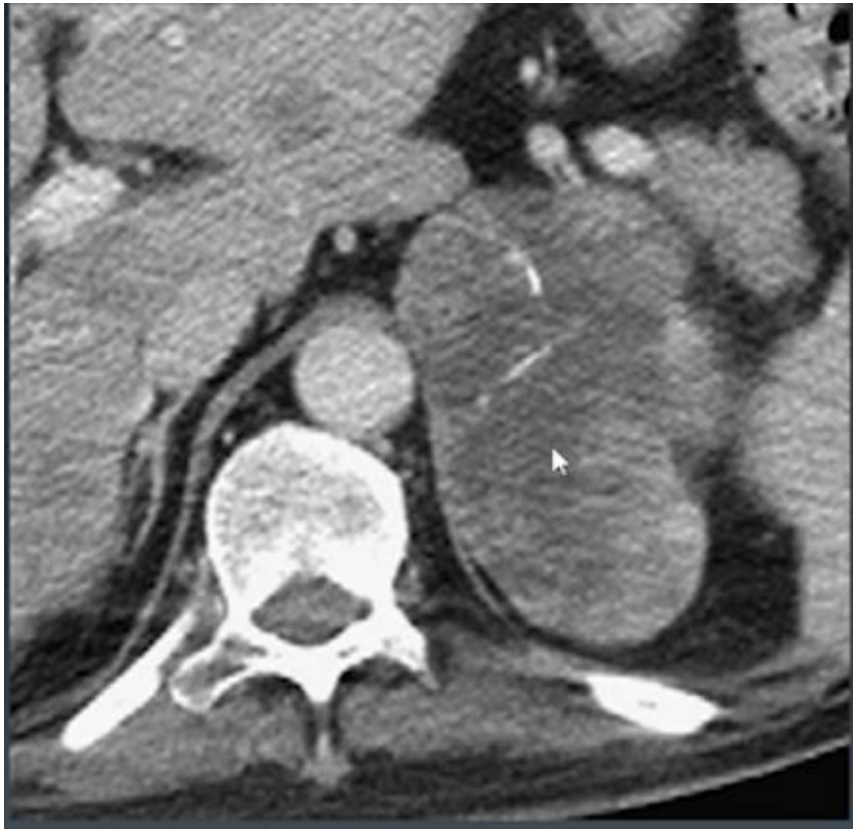
1st, 4th and 5th decades of life

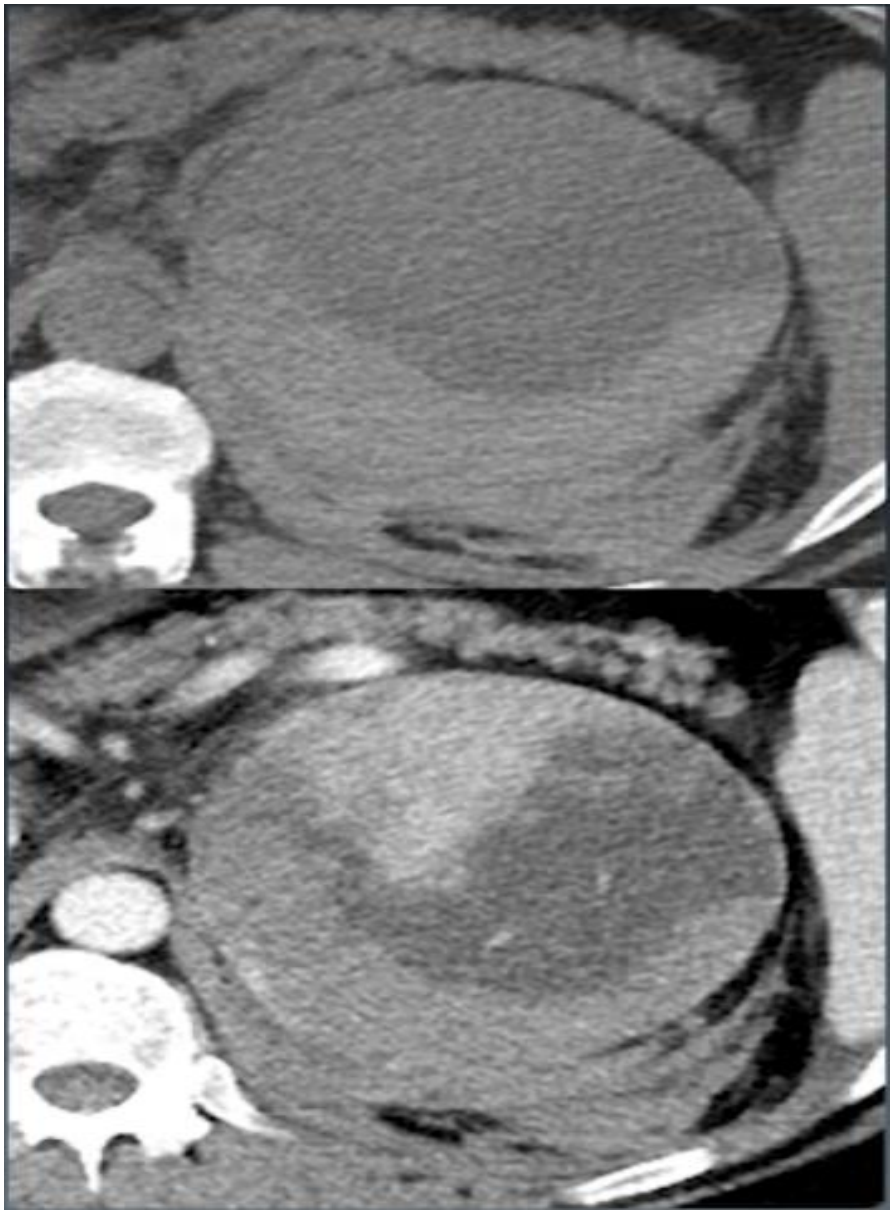
60% are functional: Cushing s/d, femization & virilization

Aggressive & Mets to liver, lung & bone.

Imaging features:

1. Large > 4 cm; Irregular margins
2. Heterogenous apperance (necrosis, hemorrhage, calcifications)
3. Very rarely (10%) can contain macroscopic fat
4. APWO < 60% & RPWO < 40%, No signal drop in OOP images
5. Local invasion to renal veins & IVC
6. Mets to lungs, liver & bones
7. PET CT: SUV > 3.1 (SUV: ratio of tissue radioactivity & administered dose: in general SUV > 2.5 s/o malignancy)

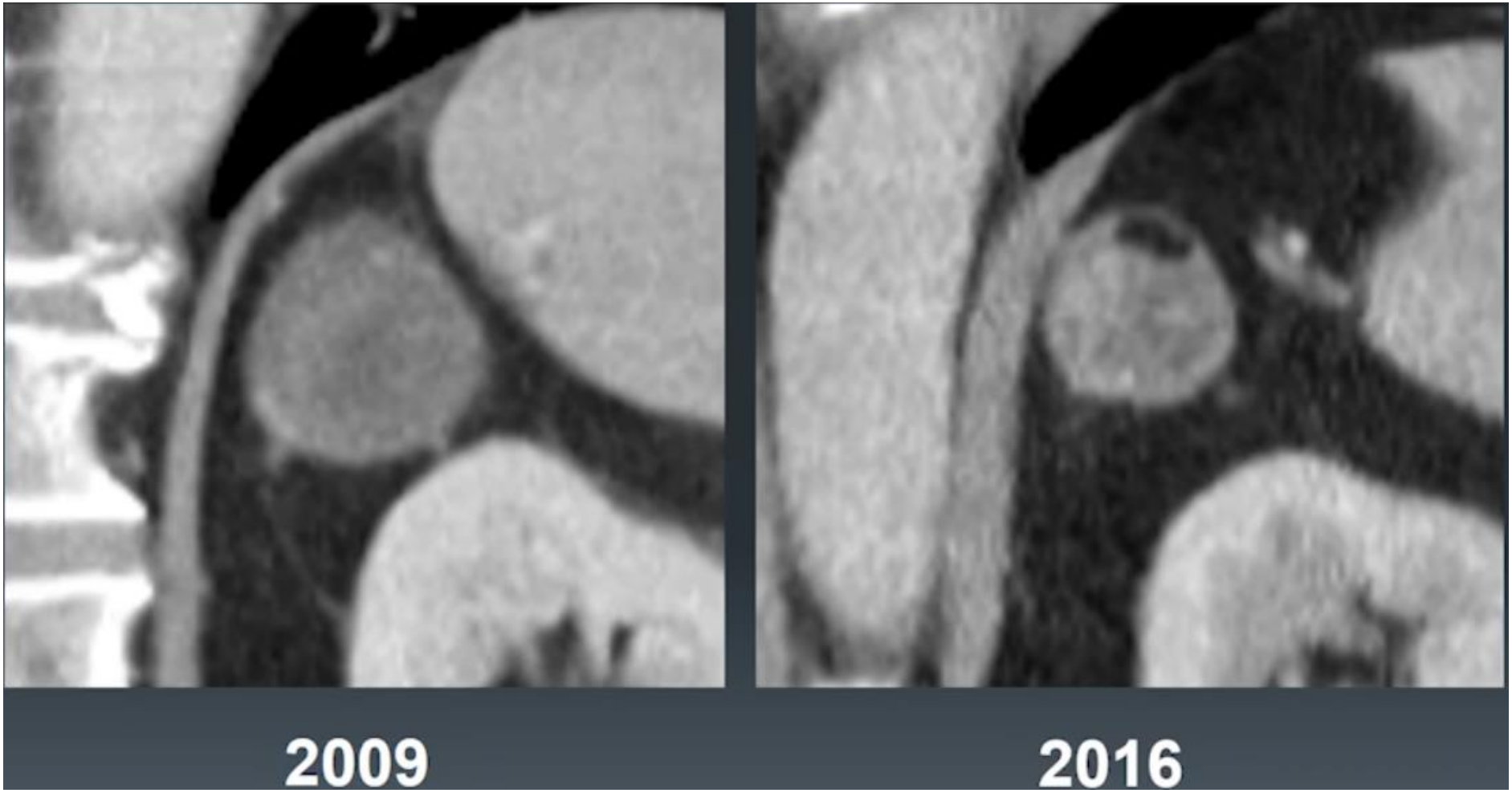




Macroscopic fat in adrenal mass

- If Macroscopic fat is > 50%, it is myelolipoma
- If Macroscopic fat is < 50%, it can be either myelolipoma / adenoma with fatty degeneration
- Rarely pheochromocytoma can contain macroscopic fat.
- 10% of adrenal cortical CA can have macroscopic fat.

- Adrenal adenoma with fatty degeneration.



6. Adrenal metastasis:

Primary in kidney, liver, lungs, breast, thyroid, melanoma & colon

Bilateral

Imaging features: non specific

Rarely can have microscopic fat (RCC, HCC)

Hypervascular metastasis can show wash out (RCC, HCC) i.e APWO>60% & RPWO>40%

Rest of them shows APWO<60% & RPWO<40%

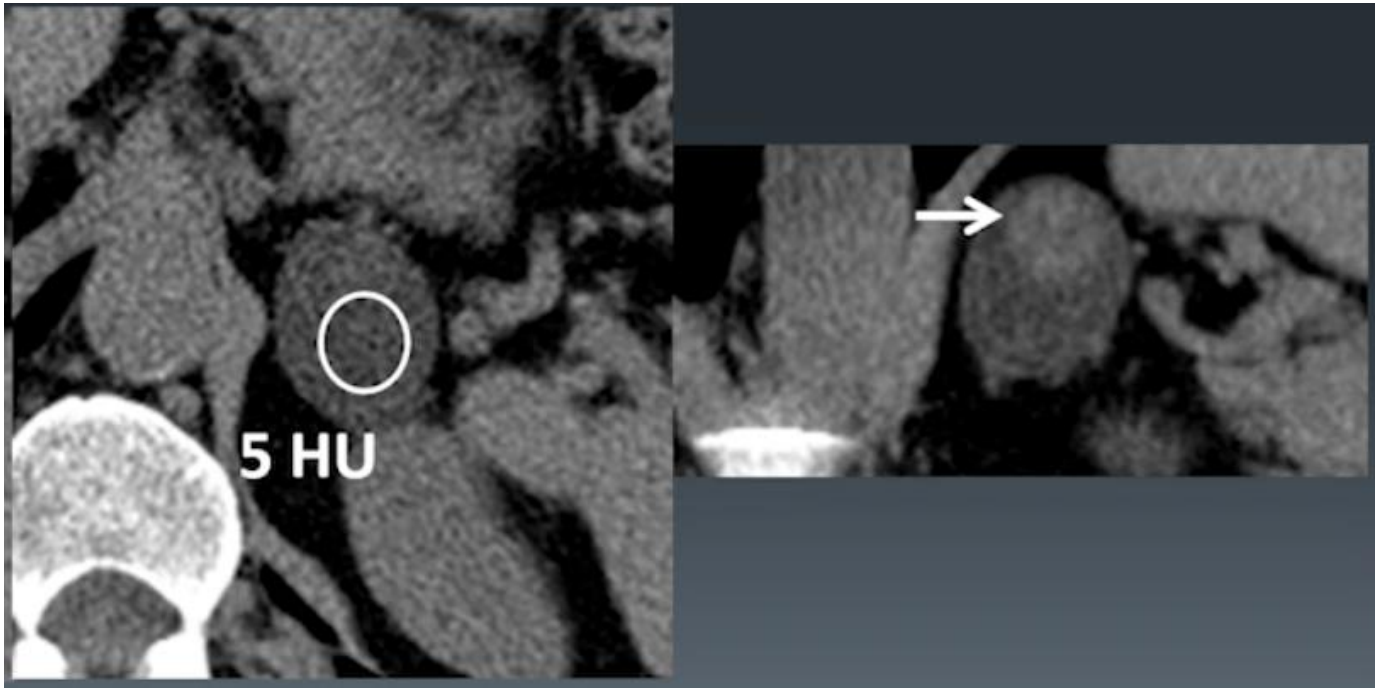
Microscopic fat in adrenal mass

- Adrenal adenoma
- Pheochromocytoma
- Adrenal metastasis (hypervascular)
- Shows washout on CT adrenal protocol.

- Adrenal collision tumour

Co existence of two separate tumours in same gland

K/c/o CA lung: metastasis to adrenal adenoma



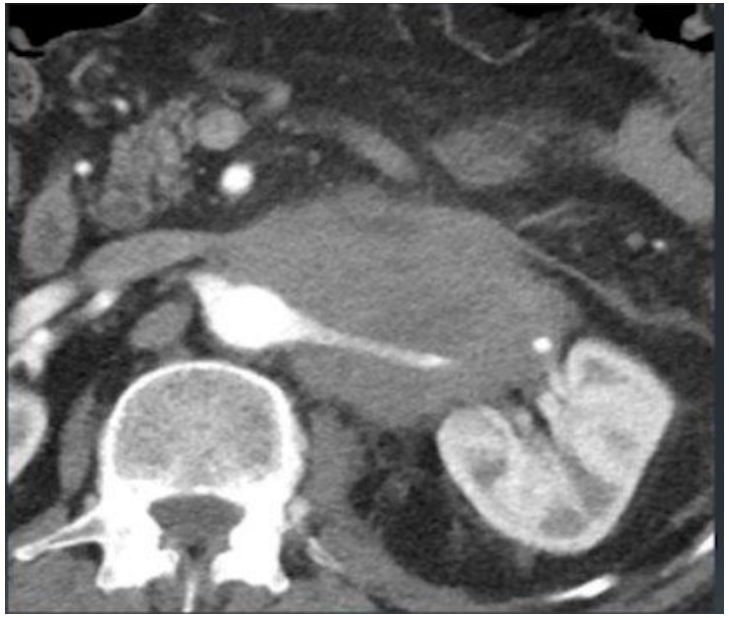
7. Adrenal lymphoma:

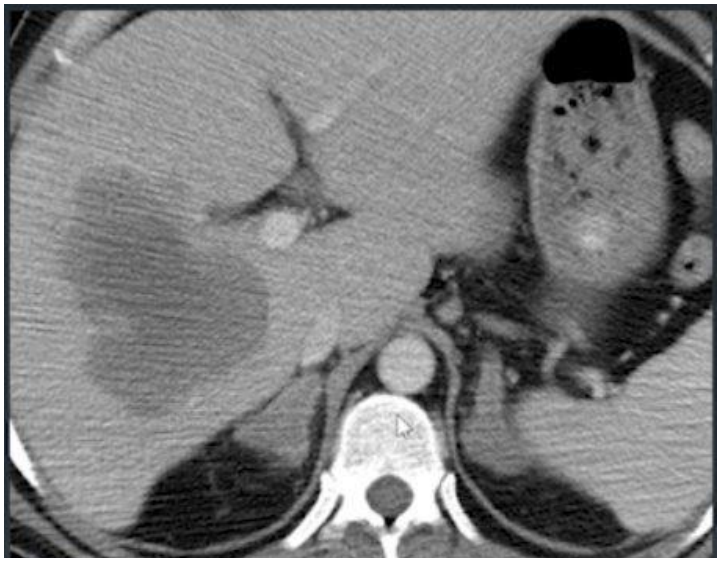
Primary is rare

Secondary from NHL

Imaging features:

- Diffuse nodular enlargement
- Soft tissue density mass, homogenous, no calcifications
- Adrenals can also be engulfed in retroperitoneal lymphoma
- No fat
- No washout





8. Adrenal haemorrhage:

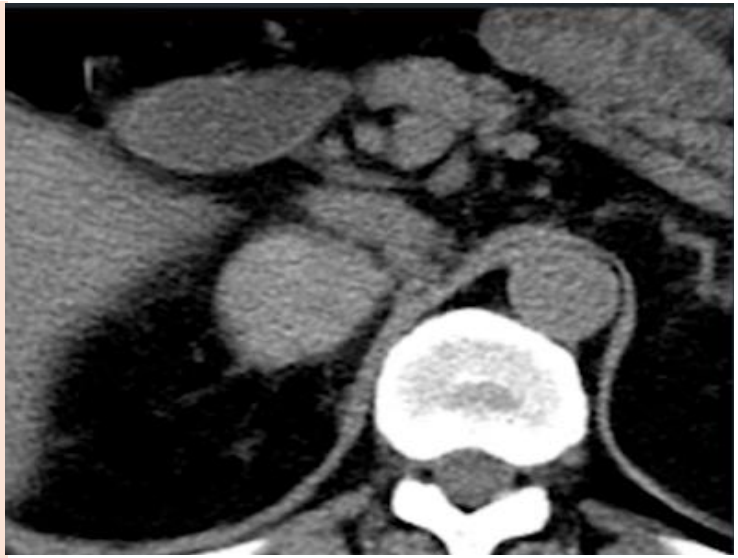
- Trauma: R > L
- Spontaneous: B/L, Stress related, bleeding disorders (APLA s/d, DIC, anticoagulants), Sepsis (Meningococcal septicemia: Waterhouse Friderichsen s/d)
- Intratumour (Adrenal cortical CA, atypical adenoma)

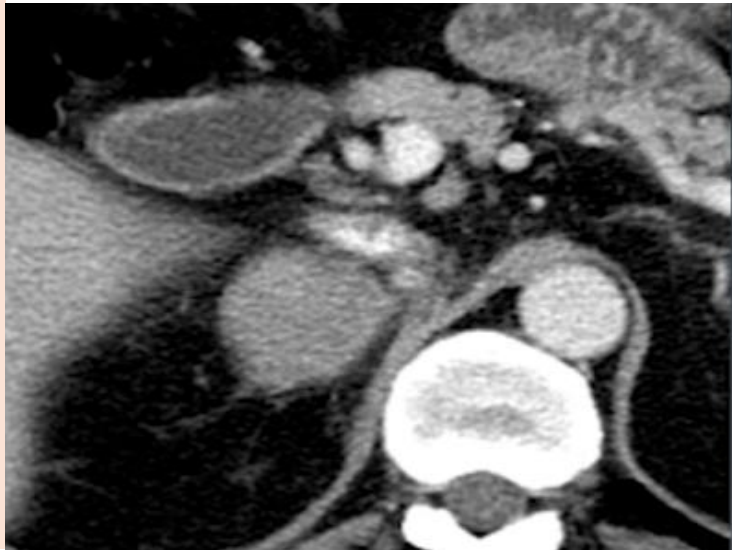
Bilateral adrenal haem can result in adrenal insufficiency / crisis

Imaging features:

- Hyperdense, non enhancing
- Chronic: calcifications, pseudocysts

Follow up recommended to ensure resolution & no underlying mass





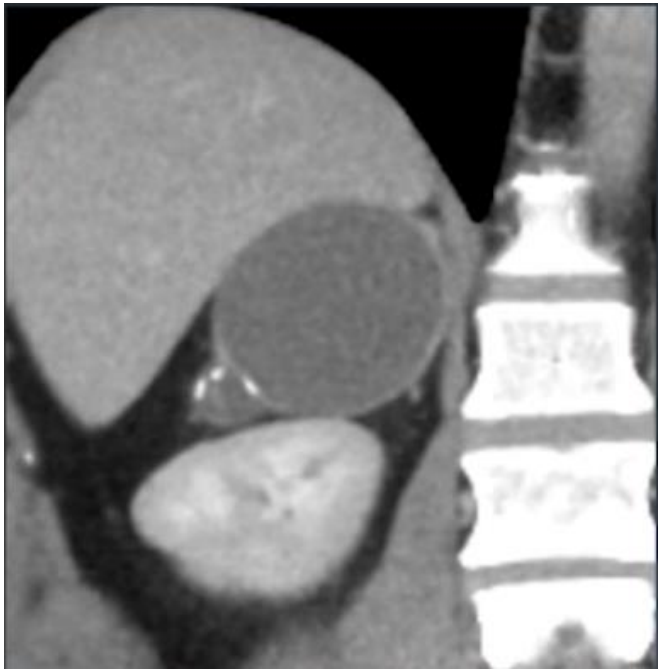
9. Adrenal cysts

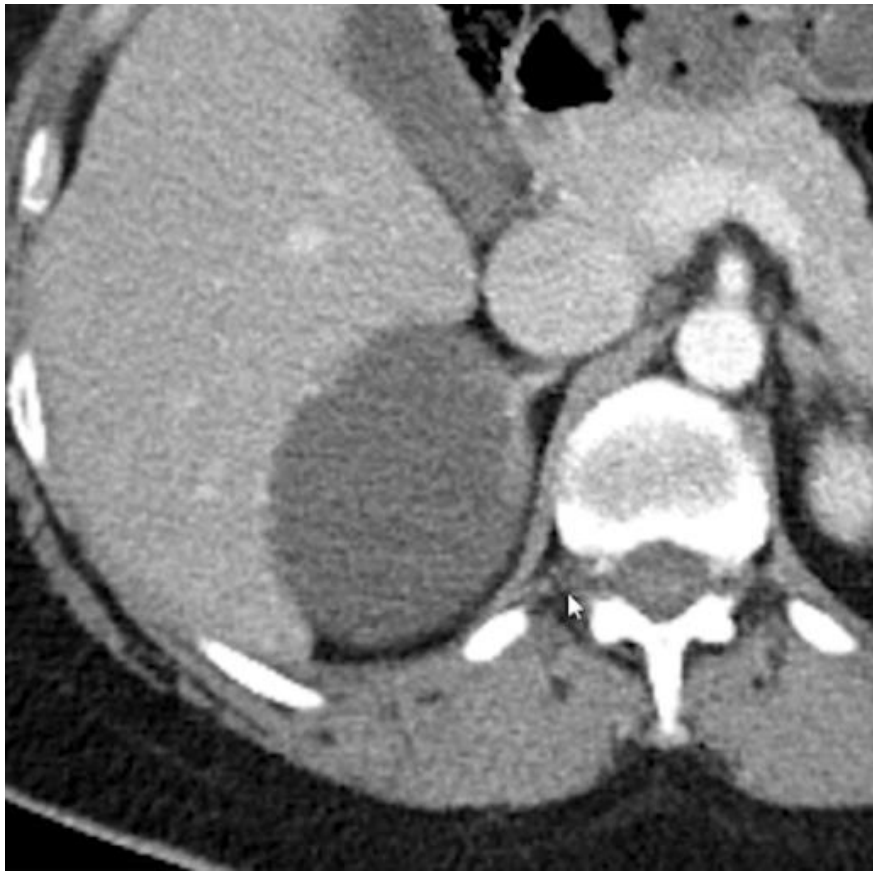
Pseudocysts: Sequalae to adrenal hemorrhage, Calcifications +

True cyst: rare

Infection: Echinococcus

Complex cyts: Solid components & thick walls





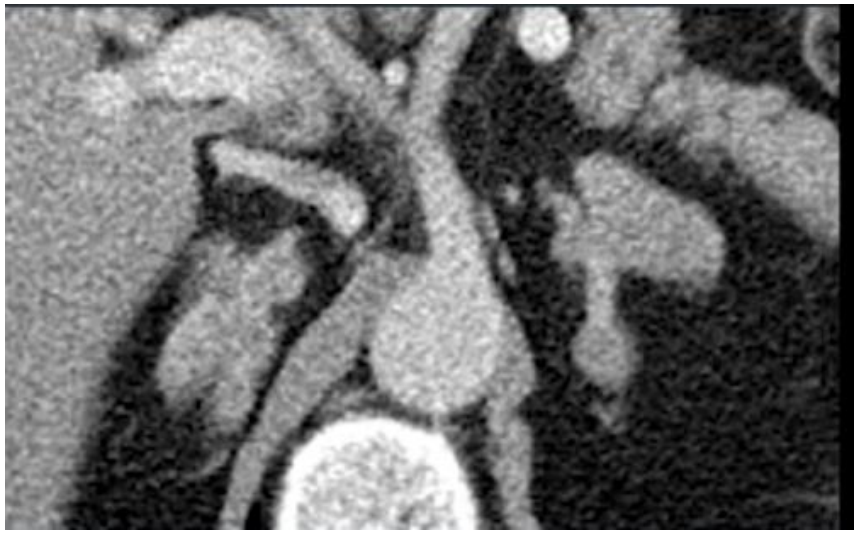
10. Adrenal hyperplasia:

Diffuse nodular enlargement

No discrete mass

Can be lipid rich / lipid poor

Rare cause of Cushing's s/d



Nuclear Medicine

I 123 MIBG used for imaging of pheochromocytoma & adrenal cortical CA

I 131 MIBG (AZEDRA) used for imaging and Rx of pheochromocytoma.

Adrenal Incidentaloma:

adrenal mass measuring greater than 1 cm that is discovered during a radiologic examination that was performed for indications other than evaluation of adrenal disease

Approach to adrenal incidentaloma

In NCCT

*Size < 1 cm: benign.

*Diagnostic imaging features of adrenal myelolipoma, simple adrenal cysts, lipid rich adrenal adenoma: benign, no f/u

*Size > 4 cm: indeterminate, biopsy, since risk of malignancy is higher; PET CT is done if malignancy h/o +

*Size 1 - 4 cm:

- Prior imaging +

Size stable for > 1year: benign, no follow up

Size increasing / new appearance: biopsy

- Prior imaging - & CA history -

Size 1 - 2 cm: probably benign, follow up in 12 months

Size 2 - 4 cm: adrenal CT protocol

- Prior imaging - & CA history +

adrenal CT protocol

*Adrenal CT protocol

- On NCCT if < 10 HU: lipid rich adrenal adenoma, no follow up

- On NCCT if > 10 HU:

-No enhancement - cyst, haemorrhage: benign, no follow up

-APW/RPW >/= 60/40%: benign, no follow up

Exceptions: pheochromocytoma & hypervascular metastasis

-APW/RPW < 60/40%: indeterminate, biopsy

- Most adrenal incidentaloma are non-functioning
- 5-10% are functioning causing subclinical / early Cushing s/d. They are at an increased of DM, HTN, obesity, dyslipidemia & osteoporosis.
- All AI are recommended further biochemical evaluation.
- 5% of AI can be pheochromocytoma