

# LIVER MRI

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MRT MRI



# Overview

- Clinical indications
- Advantages / disadvantages
- Typical sequences
- Types of contrast media
- Benign lesions
- Malignant lesions

# Clinical indications

- Anatomy of liver and adjacent structures
- Identifying location of lesions
- Number of lesions
- Characterising lesions
- Treatment / biopsy planning
- Monitoring of treatment response

# Advantages of MRI

- No ionising radiation
- Serial studies
- Non-invasive
- Multiple imaging planes
- Sensitive
- 3D with high temporal and spatial resolution
- Multiple vascular phases

# Contraindications and limitations

- Non-compatible metallic devices
- Metallic foreign body
- Severe claustrophobia
- Patient body habitus
- Ascites
- Contrast-media (Gadolinium) hypersensitivity
- Uncooperative patients

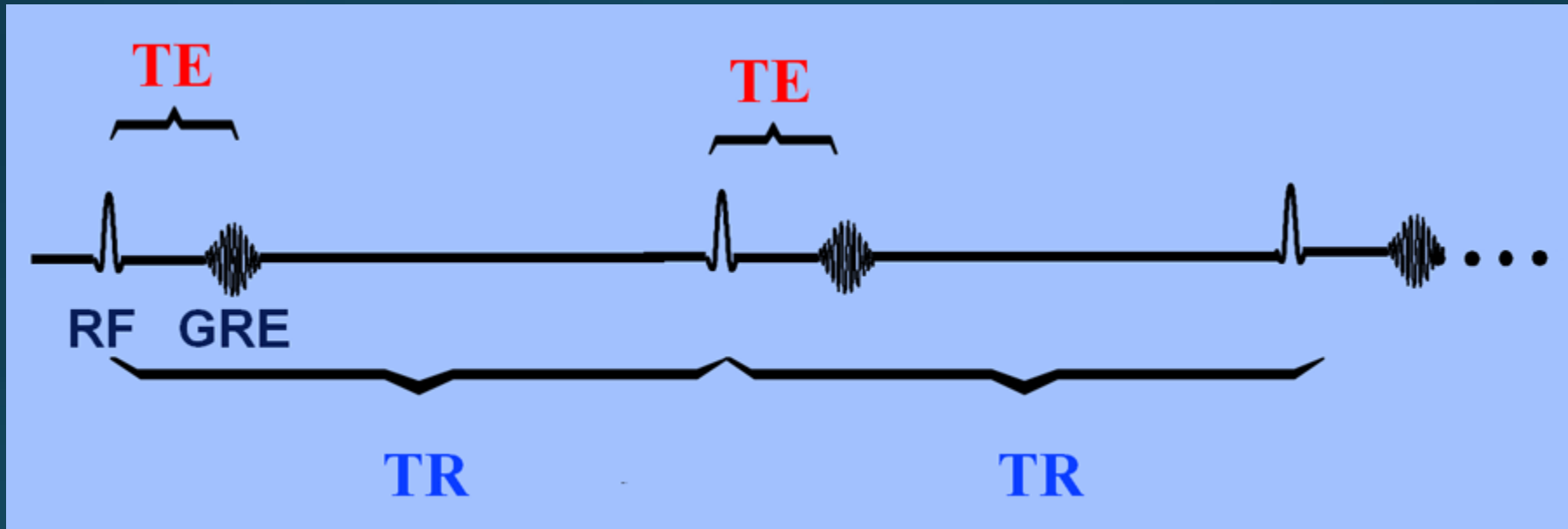
# Disadvantages

- Requires breath-holding
- Acute transient dyspnoea
- Approximately 30 minutes
- Issues with specificity
- Cost
- Availability

# Imaging sequences

- Coronal + axial T<sub>2</sub>-weighted
- T<sub>2</sub> fat saturated
- T<sub>2</sub> with an increased echo time (TE)
- T<sub>1</sub> in and out of phase (chemical shift)
- Diffusion-weighted imaging (DWI) with apparent diffusion coefficient (ADC) calculation
- Pre contrast T<sub>1</sub>-weighted 3D
- Post contrast T<sub>1</sub> 3D in arterial, venous, equilibrium and delayed phases.

# TR and TE

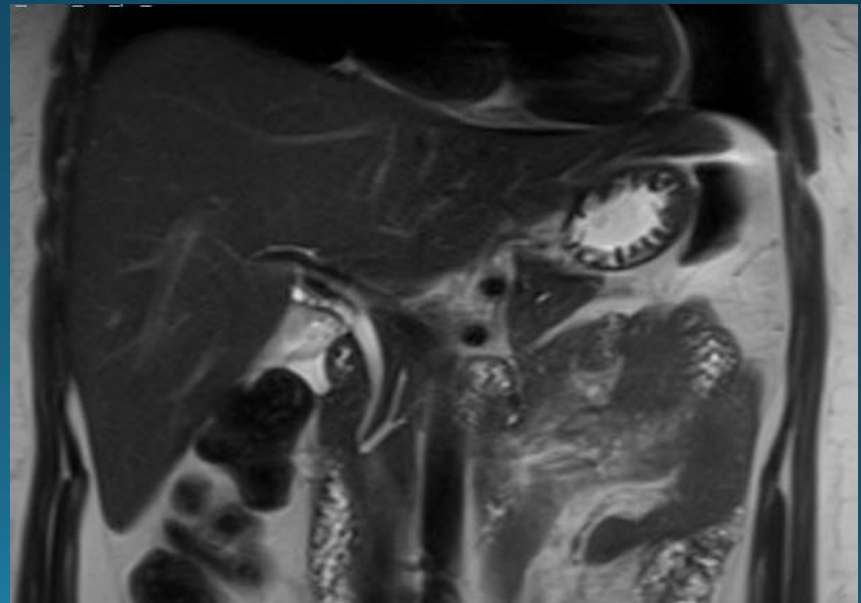
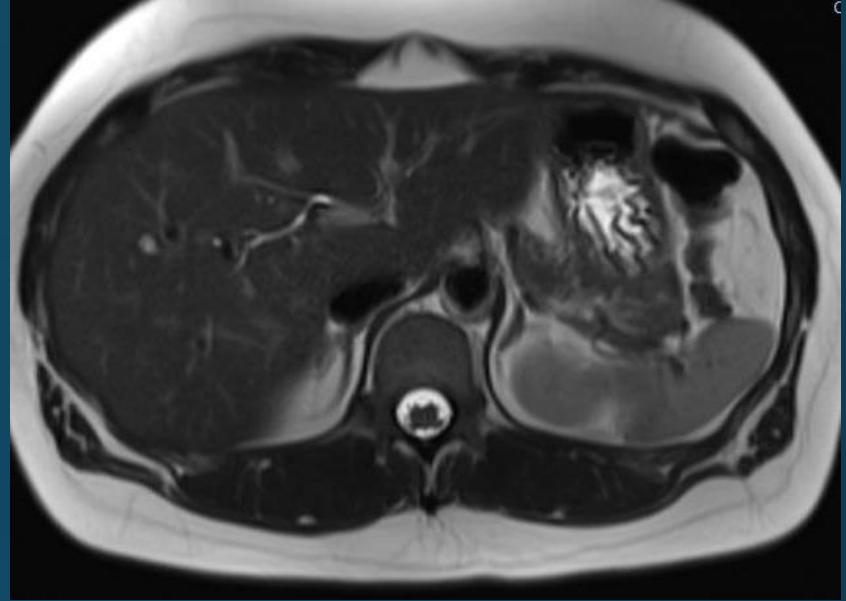


Repetition time (TR) Echo time (TE)



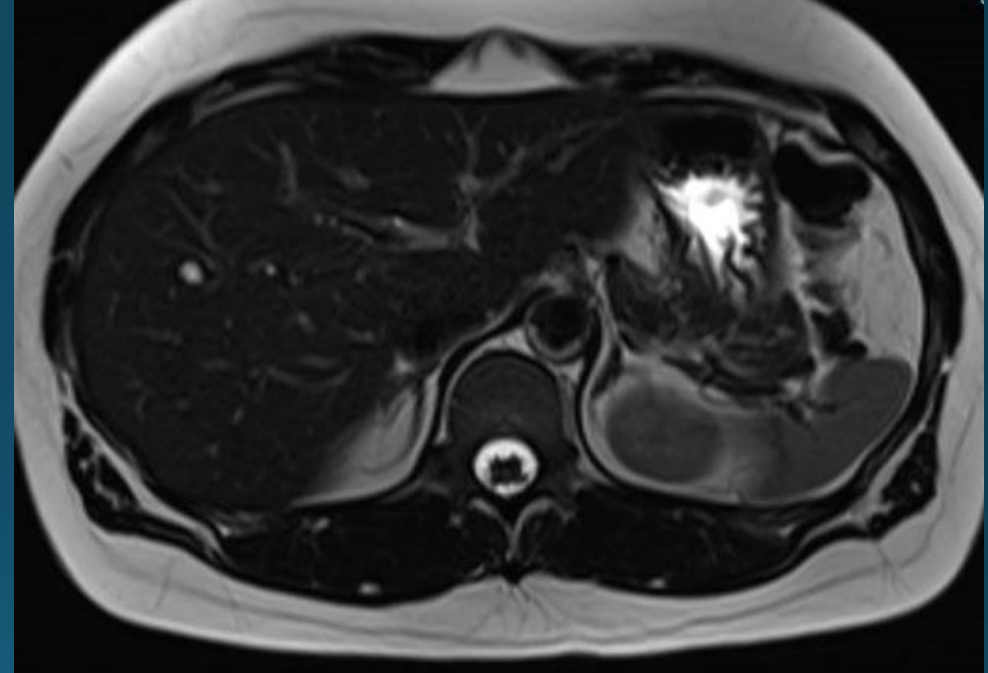
# T2-weighted

- Long echo time (TE) and long repetition time (TR)
- Water is hyperintense (bright)
- Fat is hyperintense
- Pathology scan
- Single-shot acquisition

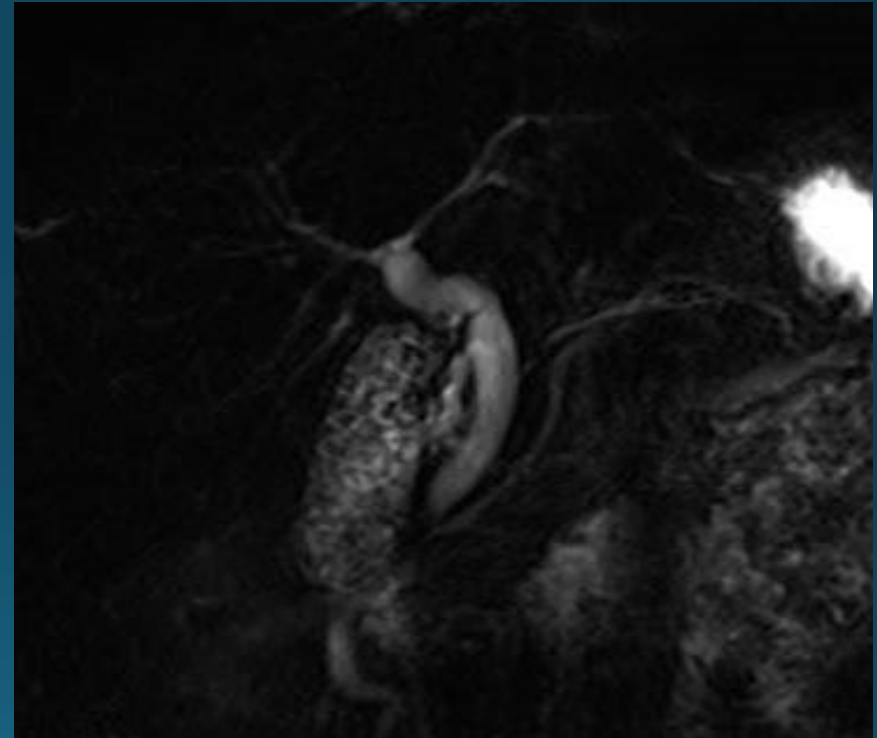
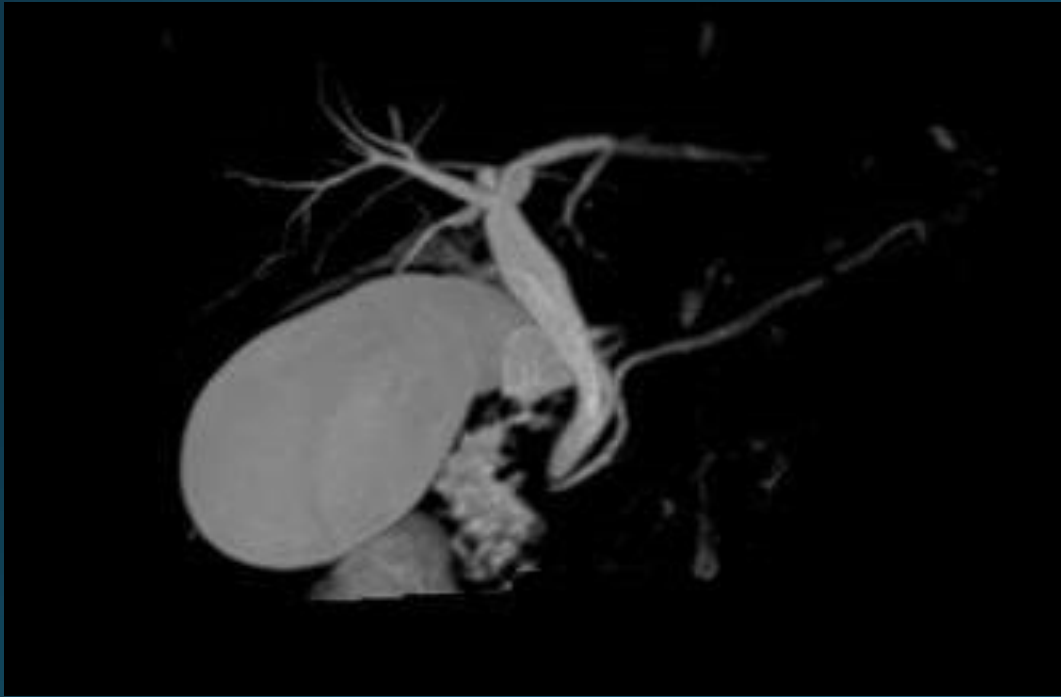


# T2-weighted long TE

- Increasing TE decreases background tissue signal
- Increased signal difference between fluid and tissue
- As TE increases metastases lose signal intensity
- Haemangiomas and cyst remain hyperintense

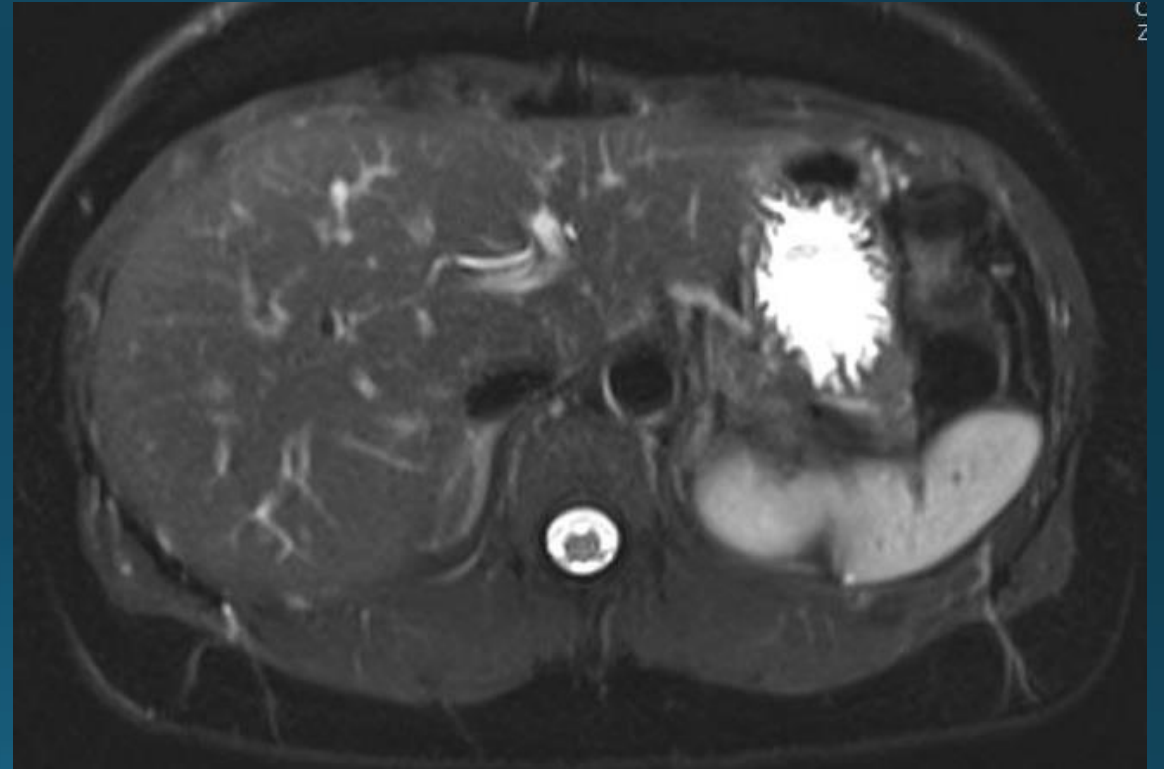


# T<sub>2</sub> SPACE MRCP



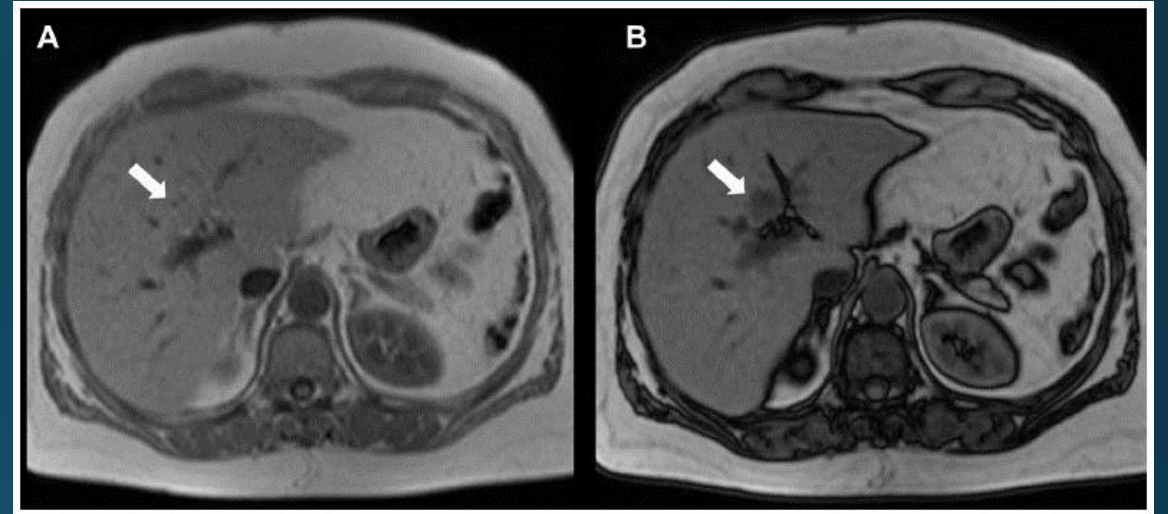
# T2 fat suppressed images

- Additional pulses applied to suppress signal from fat
- Can be applied to multiple sequences
- Increase conspicuity of lesions



# T<sub>1</sub> in and out of phase

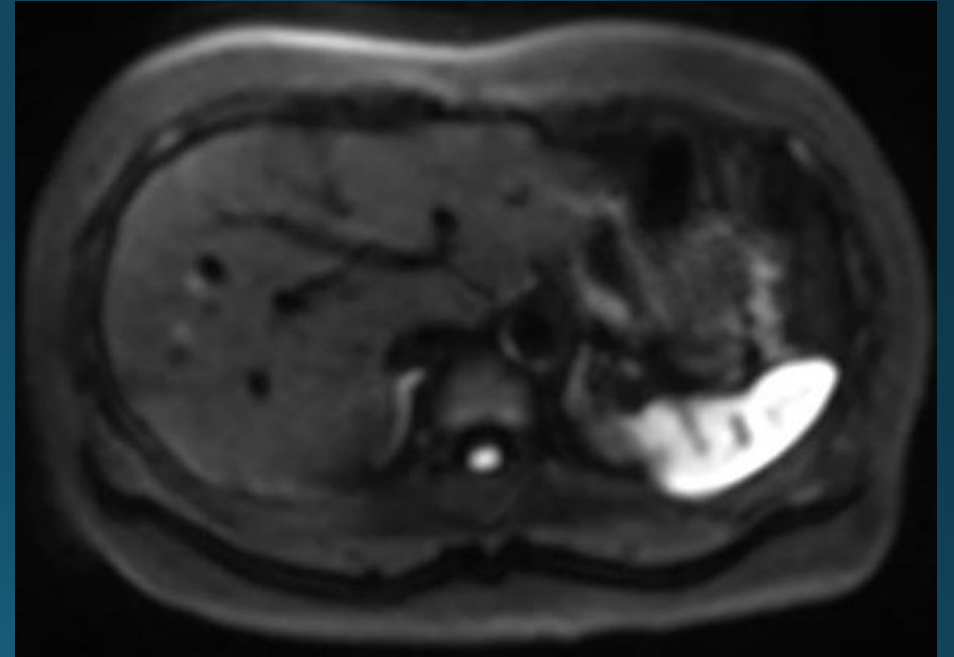
- Utilises chemical shift
- Identifies abnormal fatty accumulation
- In-phase (A)- fat appears isointense to parenchyma
- Out-of-phase (B) - hypointense
- Iron-storage disease



Luersen et al. 2015

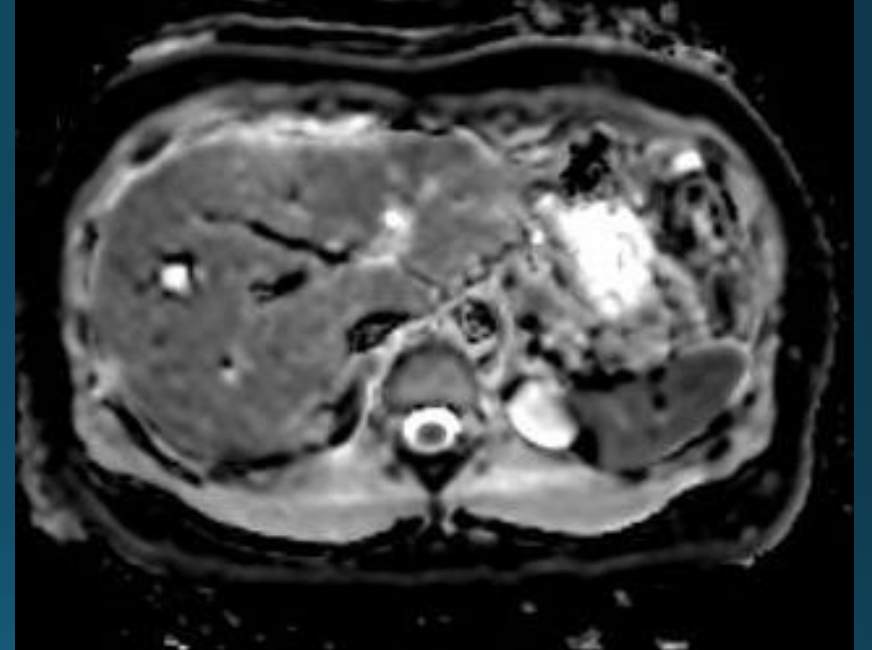
# Diffusion-weighted imaging

- Microscopic water motion
- Brownian motion
- Restricted water motion
- Identifying metastases with better sensitivity and specificity than CT (Albiin, 2012)
- Identifying extrahepatic lesions and lymph nodes
- Diffusion restriction appears hyperintense to liver



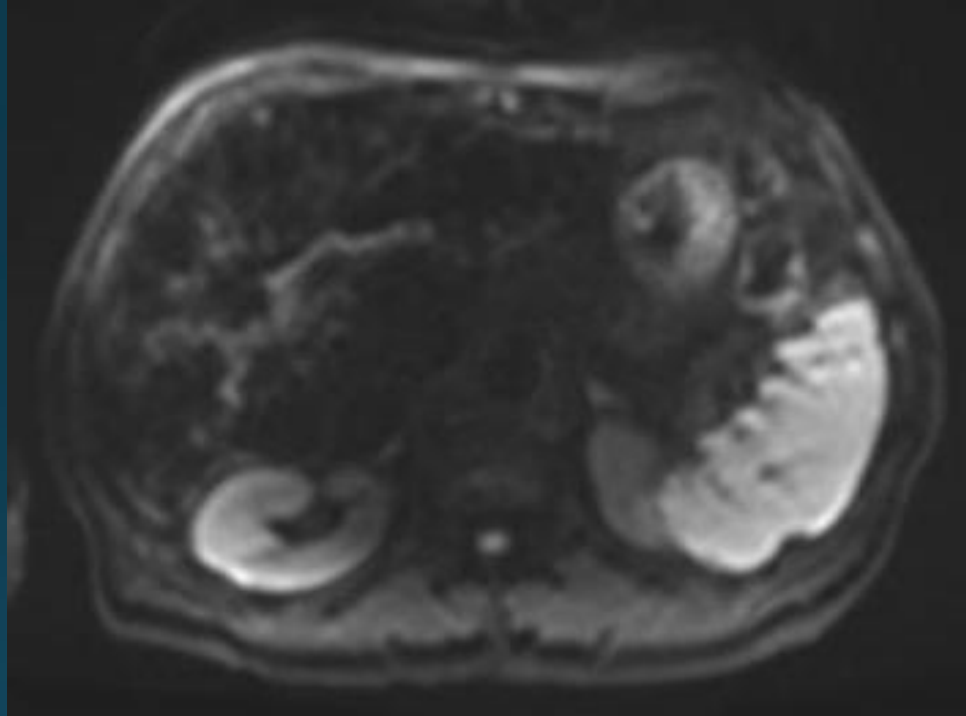
# Apparent diffusion coefficient (ADC)

- Measure of magnitude of diffusion within a tissue
- Calculated from DWI
- Expressed as  $\text{mm}^2/\text{s}$
- Hyperintense areas on DWI corresponding with hypointense areas on ADC = diffusion restriction

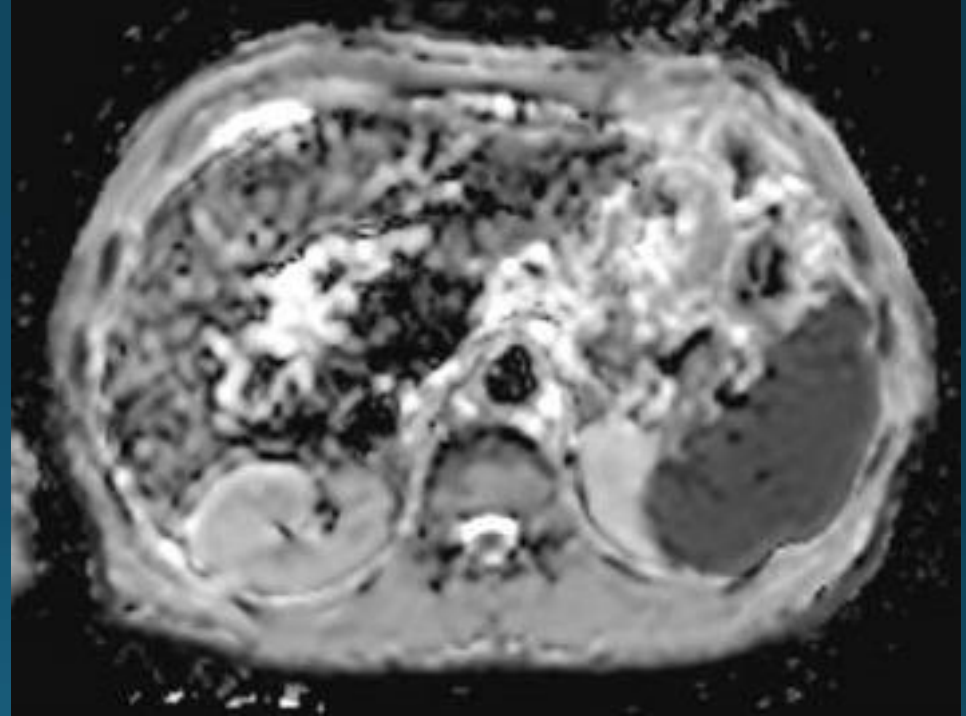




# DWI / ADC cirrhotic liver



DWI

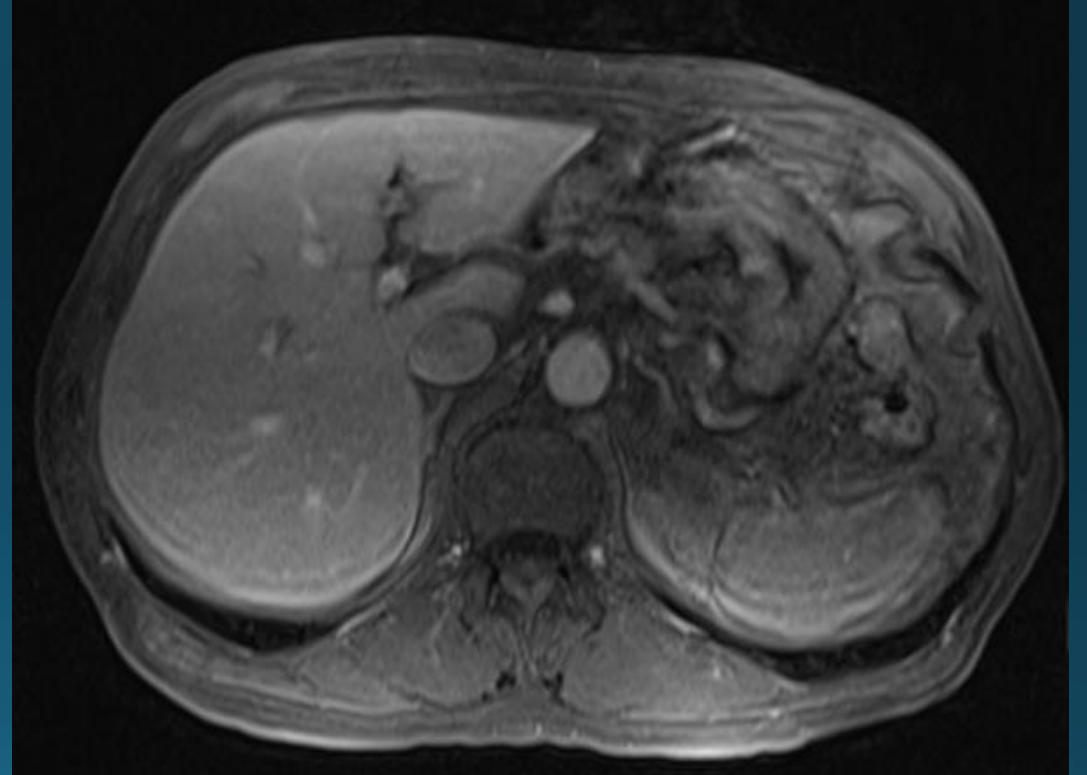


ADC



# T<sub>1</sub> imaging

- Fluid is hypointense
- Fat remains hyperintense
- fat suppression
- 3D rapid T<sub>1</sub> sequence
- Contiguous slices
- Both pre contrast media and post contrast series



# Non-liver specific contrast

- Often first visit
- Low suspicion of malignancy
- Cheaper and readily available
- Solid vascular lesions = enhance
- Cystic necrotic = no enhancement
- Predominantly renal excretion
- Hypervascular lesions enhance early and intensely
- Hypovascular lesions enhance later and less

# Liver specific contrast

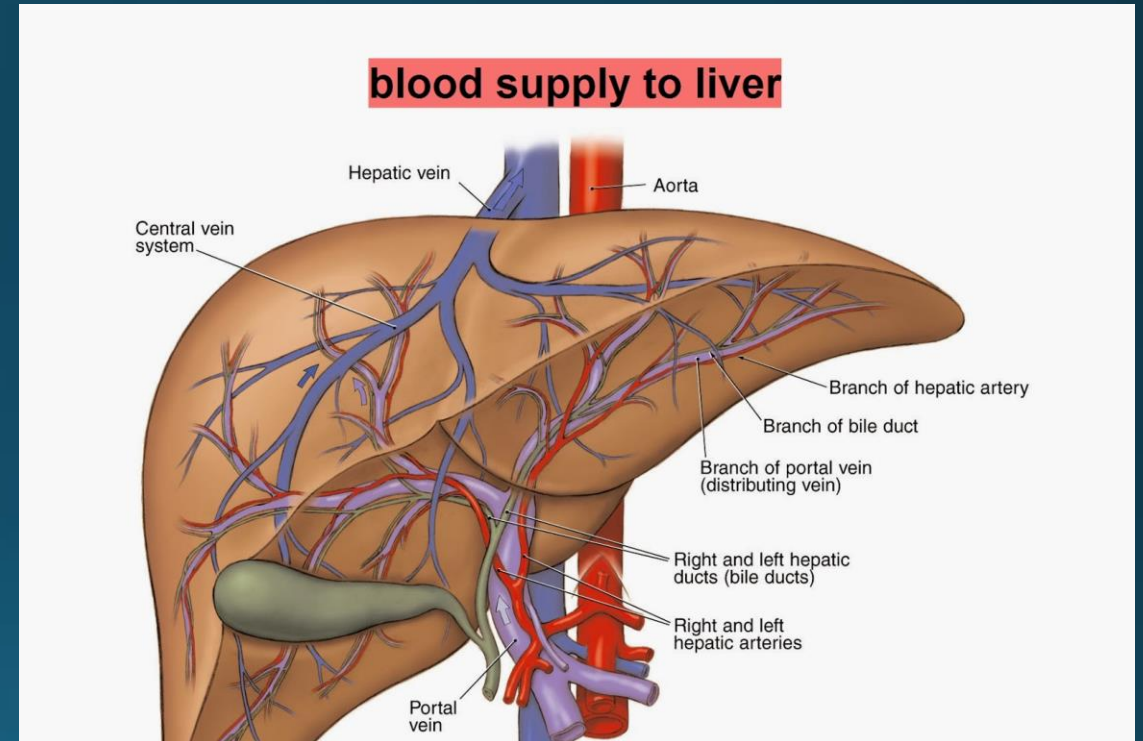
- Two main types;
  - Primovist (Gadoxetic acid), Bayer Healthcare
  - Multihance (Gadobenate dimeglumine), Bracco
- Initial enhancement is vascular + extracellular spaces
- Approx. 50% accumulates in hepatocytes
- Excreted by biliary tract
- Remainder excreted via kidneys

# Gadolinium safety

- Extremely low incidence of adverse drug reaction
- Minor reactions - nausea, vomiting, headache, itching, urticarial
- Moderate reactions – bronchospasm, laryngospasm, tachycardia
- Severe – anaphylatoid reaction
- Generally not given in pregnancy, on infants or those in renal failure

# Blood supply to Liver

- 25% hepatic artery
- 75% blood by hepatic portal vein
- Hepatic portal system connects capillaries of gastrointestinal tract to liver capillaries



# Post contrast imaging

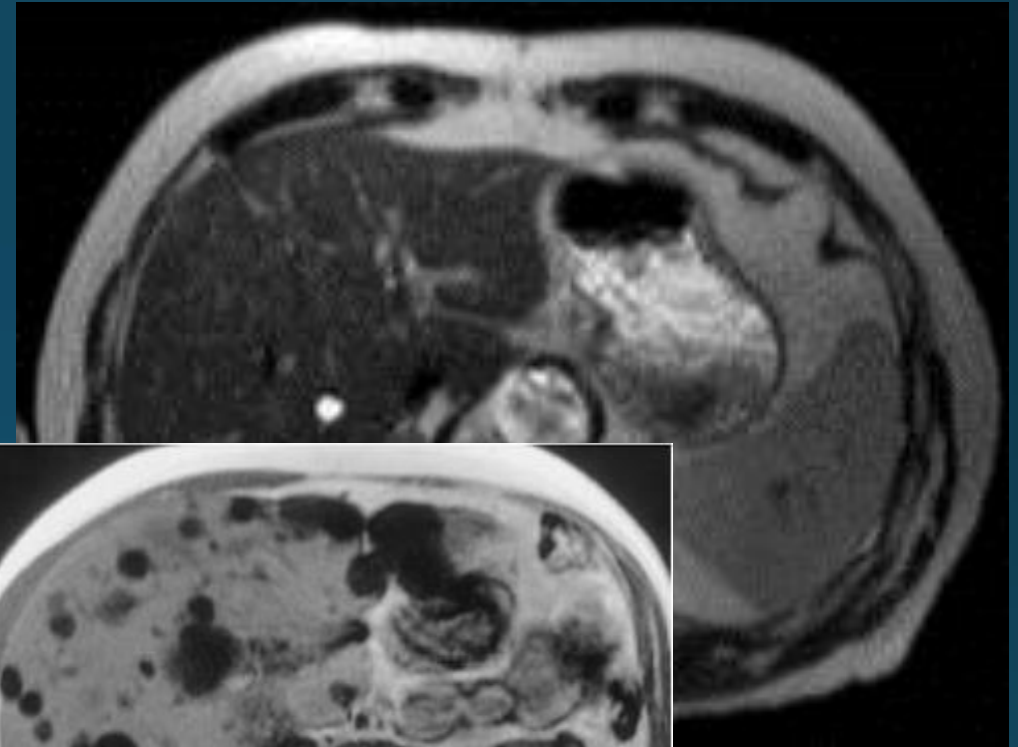
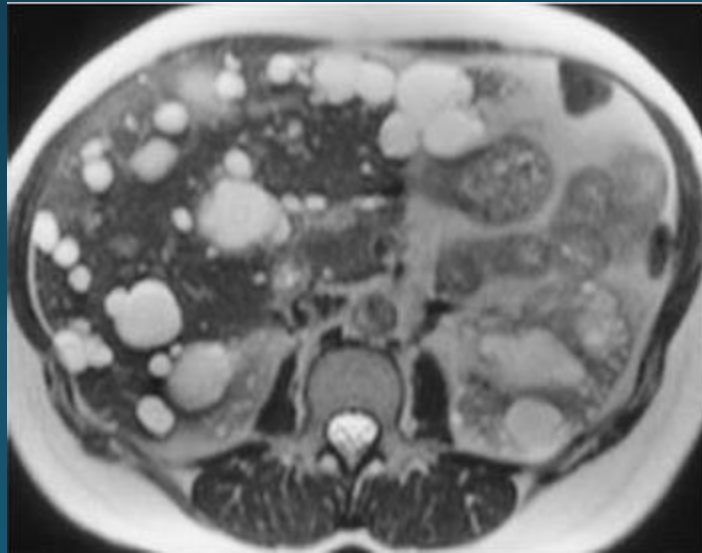
- Arterial phase – 20-25 seconds
- Portal venous phase – 60-70 seconds
- Equilibrium phase – 3-5 minutes
- Hepatobiliary phase – 20 minutes
- Delayed phase - >1 hour (dependant on contrast media)

# Benign lesions

- Haemangioma
- Focal nodular hyperplasia (FNH)
- Adenoma
- Cysts
- Abscess

# Cysts

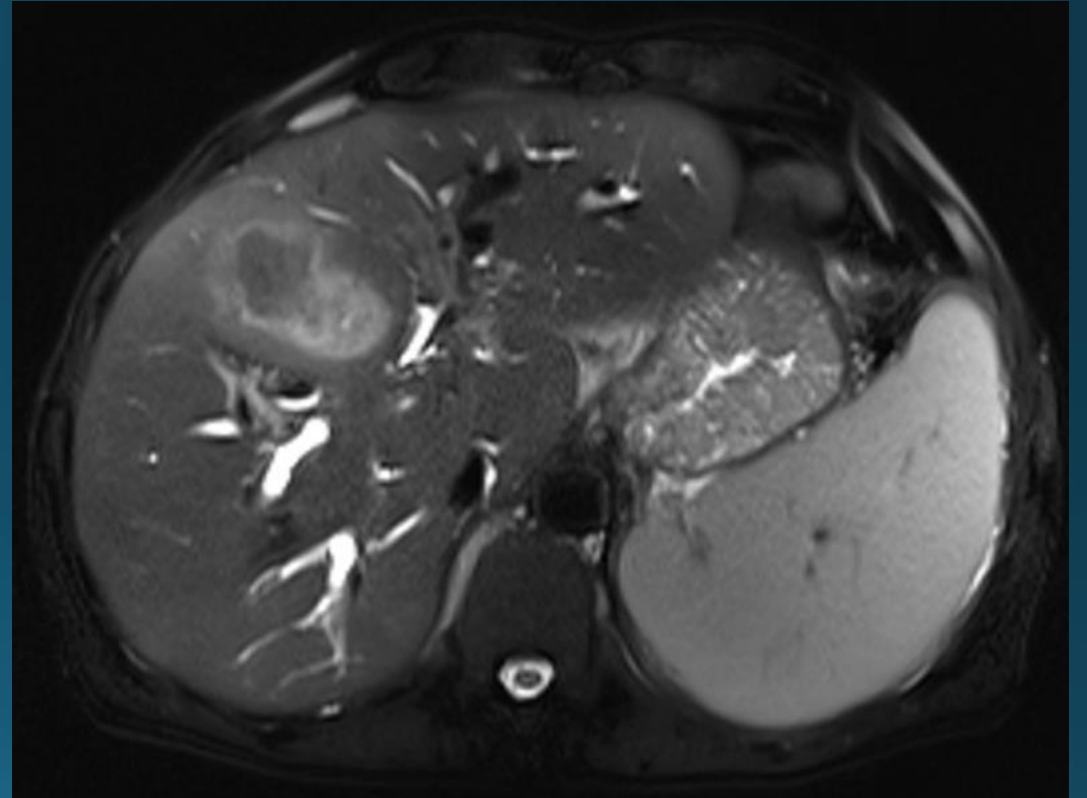
- Very T<sub>2</sub> hyperintense
- T<sub>1</sub> hypointense
- Imperceptible wall
- No contrast-enhancement





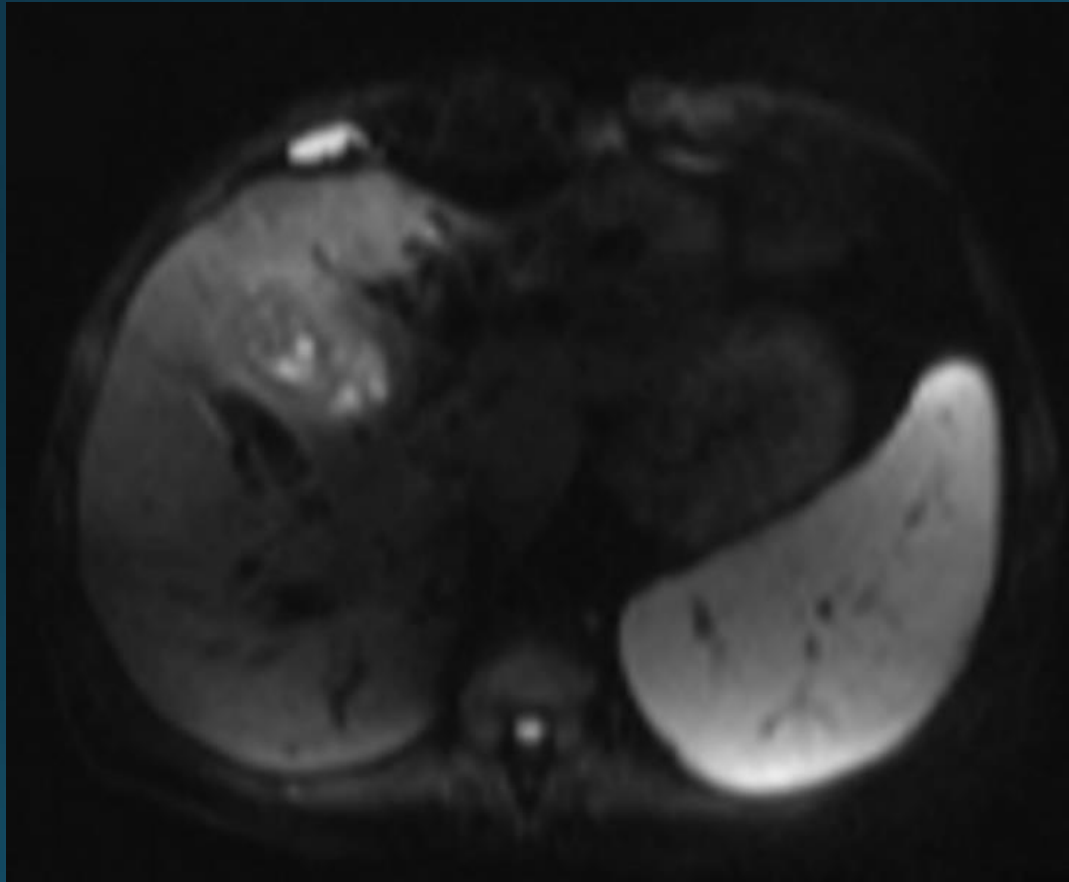
# Abscess

- Mildly T2 hyperintense
- T1 hypointense
- Contrast enhancing rim
- Restricted diffusion (hyperintense) centrally on DWI with a low ADC value

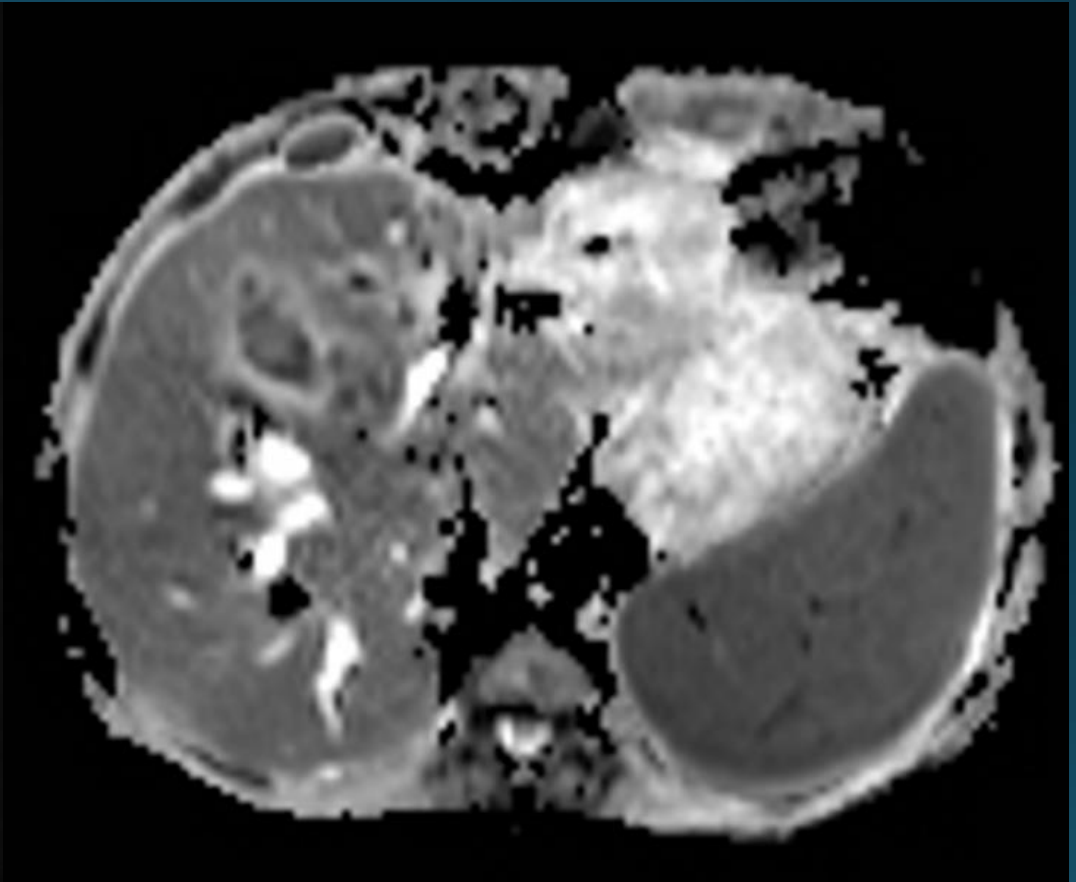


T2 fat suppressed

# Abscess



DWI

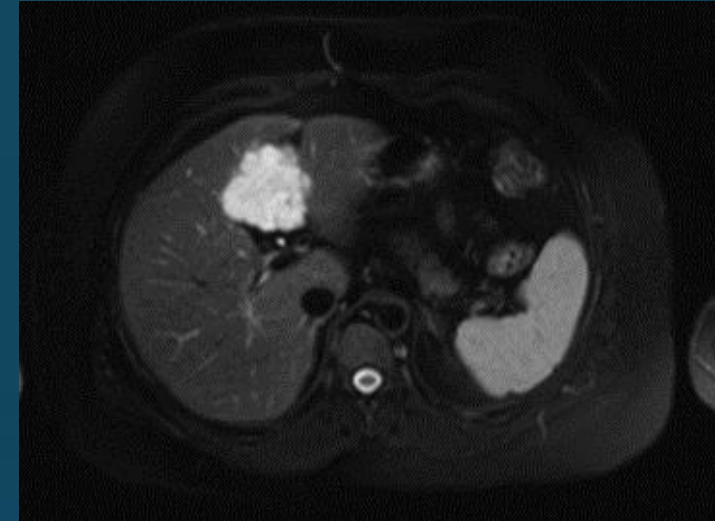


ADC

# Haemangiomas

- Well delineated
- T2 hyperintense
- T1 hypointense
- Early contrast enhancement is peripheral and nodular
- Progressive central filling in later phases
- Small lesions may be mistaken for HCC or mets

Gangahdar et al, (2014)



T2 fat suppressed

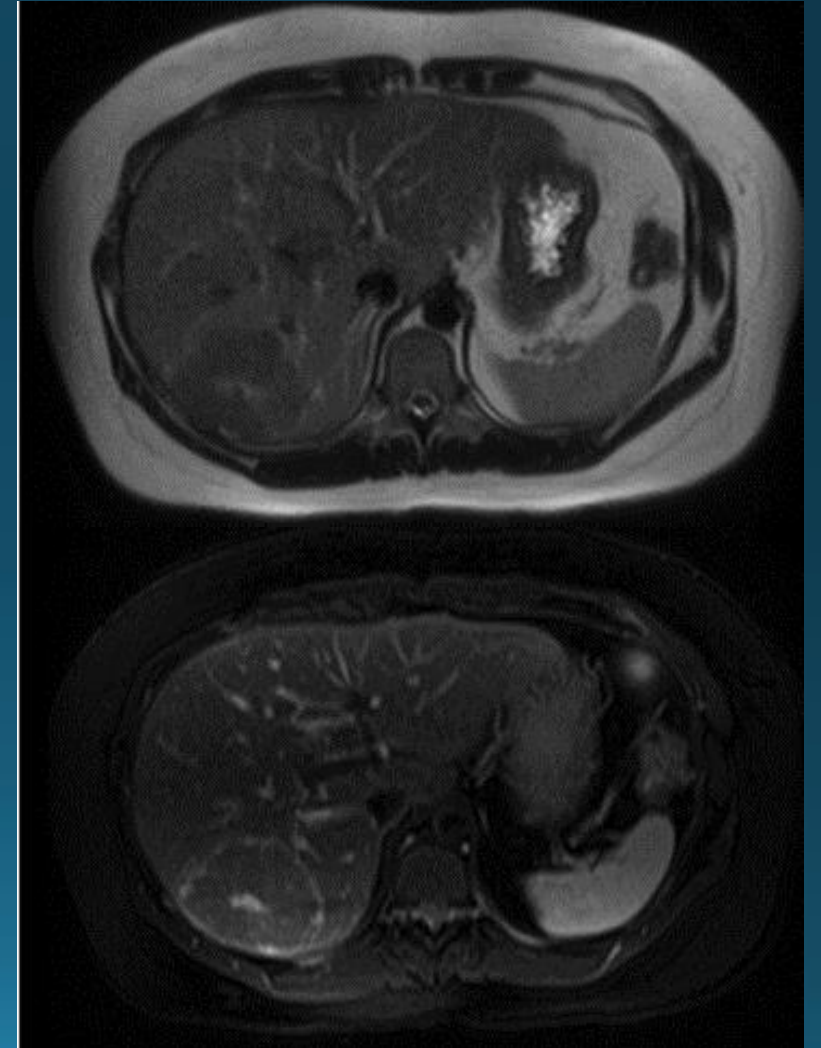


T1 fat suppressed arterial phase

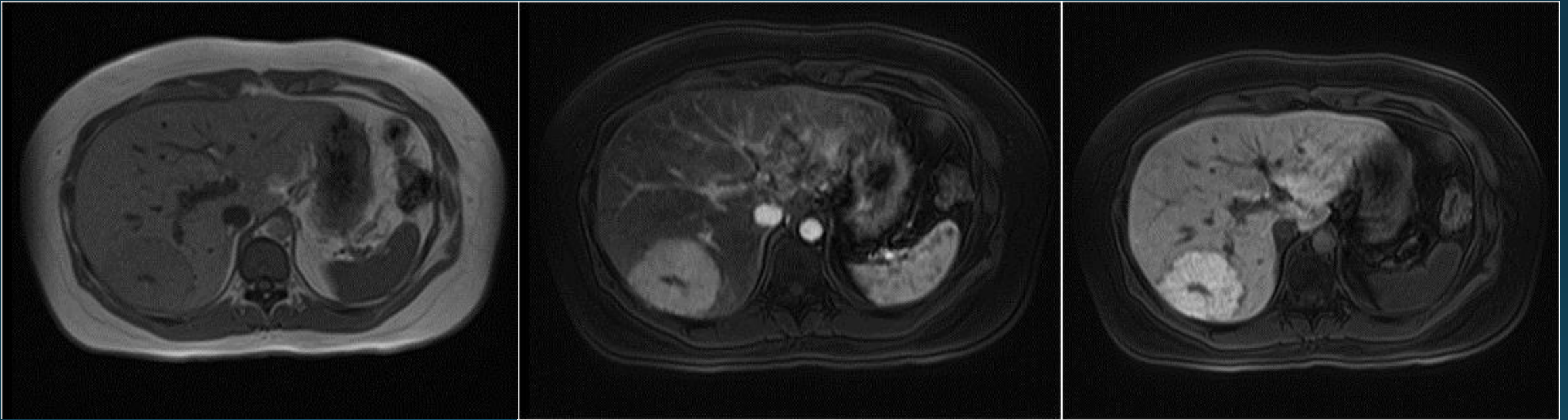
# Focal nodular hyperplasia (FNH)

- T2 hyper -isointense
- T1 hypo-isointense
- Rapid intense enhancement in arterial phase
- Become isointense to parenchyma in venous and equilibrium phases
- Delayed phase = hyper-isointense

Gangahdar et al, (2014)



# Focal nodular hyperplasia (FNH)



T<sub>1</sub> pre contrast

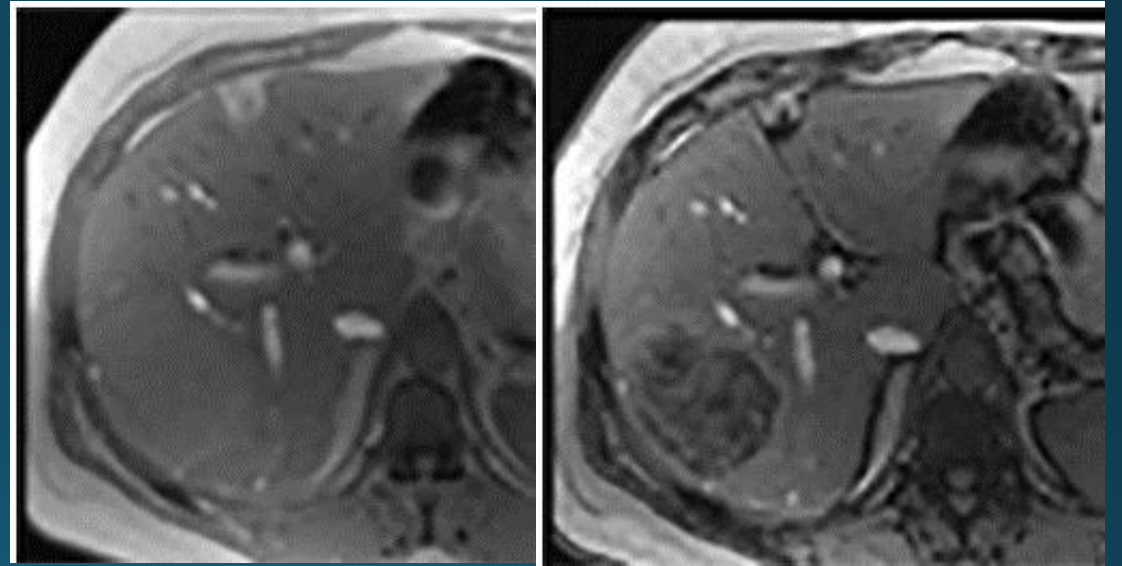
Arterial Phase

Delayed phase



# Hepatocellular adenoma (HCA)

- T2 + T1 heterogeneous
- May contain fat within lesion
- Heterogeneous enhancement in arterial phase
- Little or no contrast washout
- Isointense on portal venous and subsequent phases

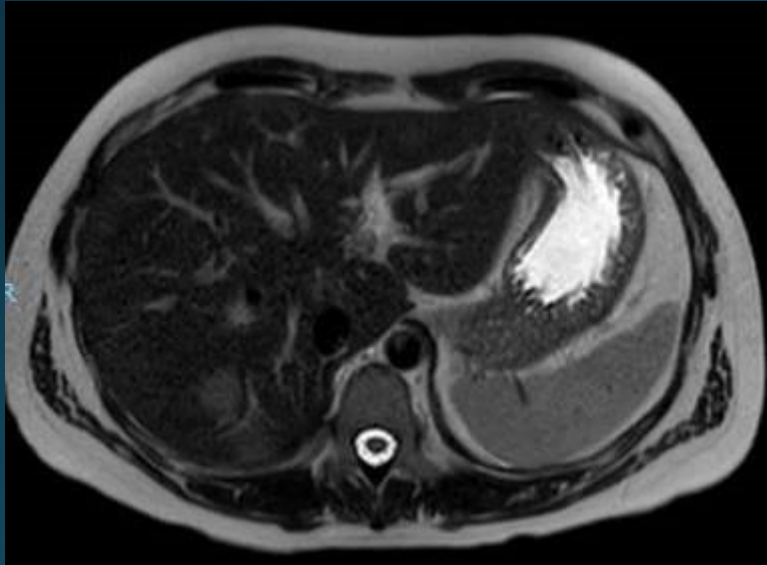


In phase

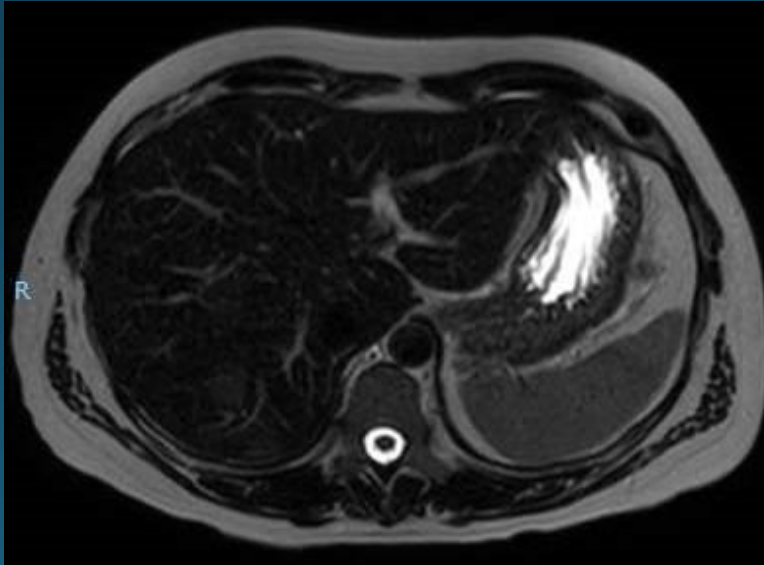
Out of phase

# Multiple hepatic adenoma

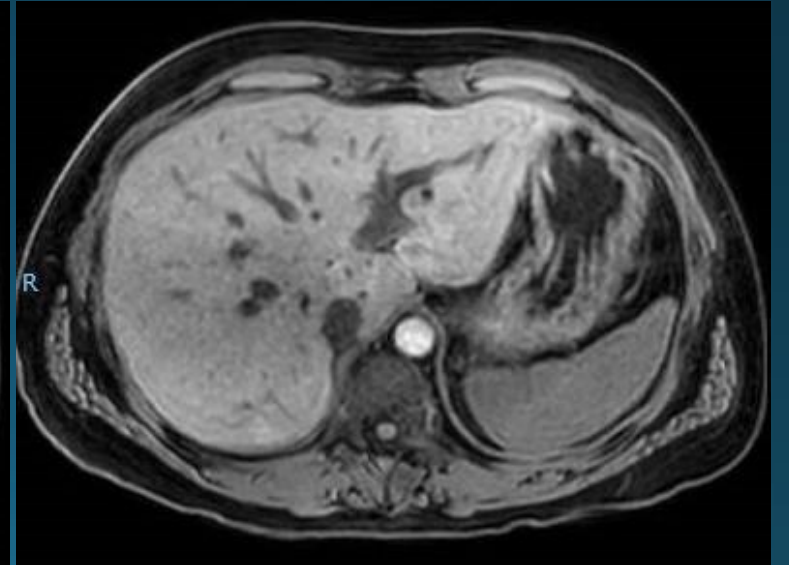
- 41 year old female
- Multiple hepatic adenomas



T2



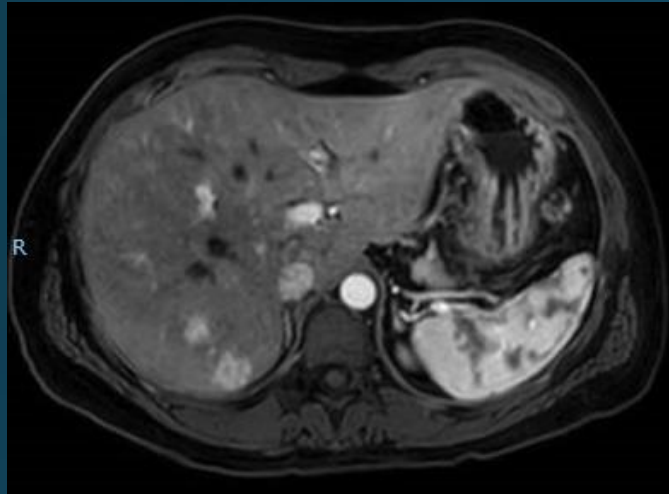
T2 long TE



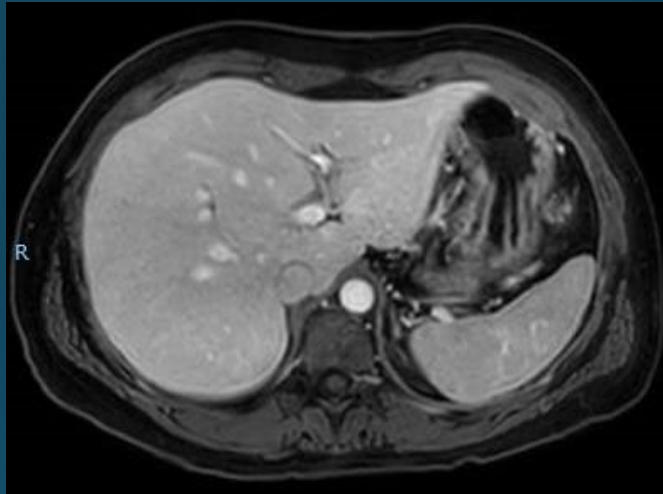
T1 pre contrast

# Multiple hepatic adenoma

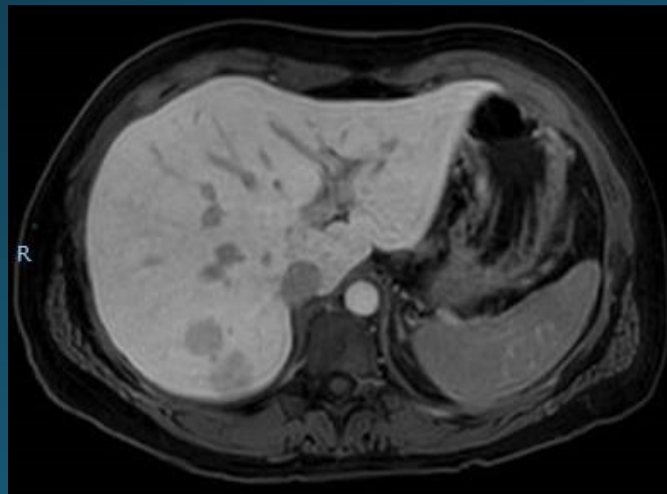
Arterial



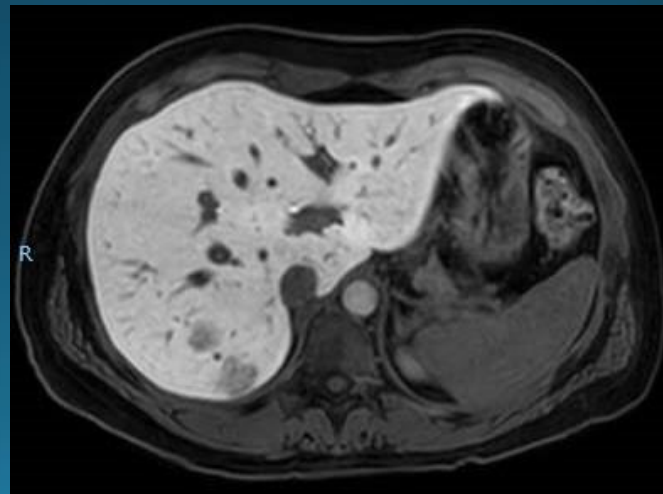
Portal venous



4 mins



20 mins delayed



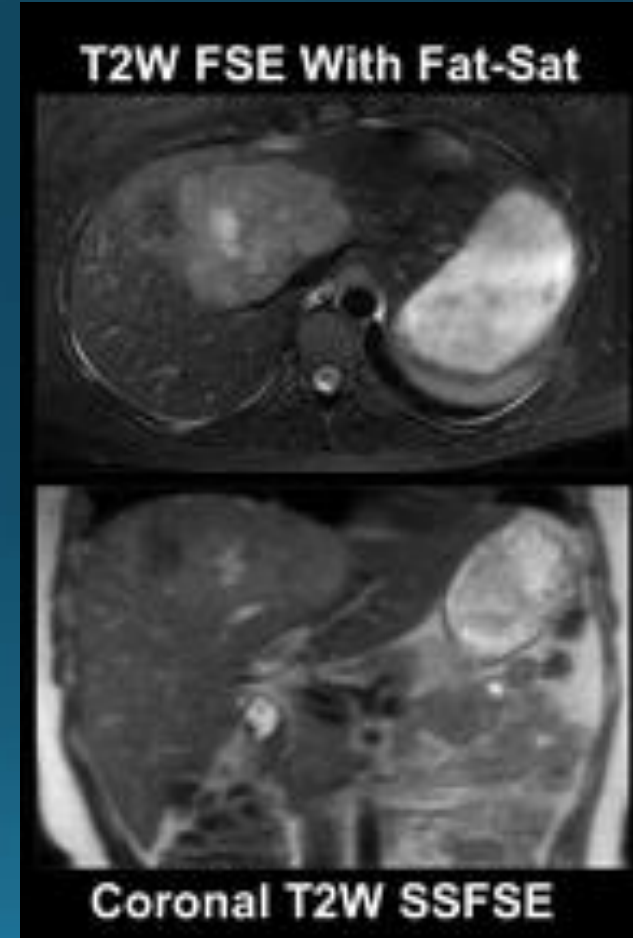


# Malignant tumours

- Hepatocellular carcinoma (HCC)
- Cholangiocarcinoma
- Metastatic lesions
- Hepatoblastoma
- Sarcomas - varied

# Hepatocellular carcinoma (HCC)

- A number of characteristic features
- Mosaic pattern
- Tumour capsule
- Extracapsular extension
- Satellite nodules
- Vascular invasion
- Metastatic with lymph involvement

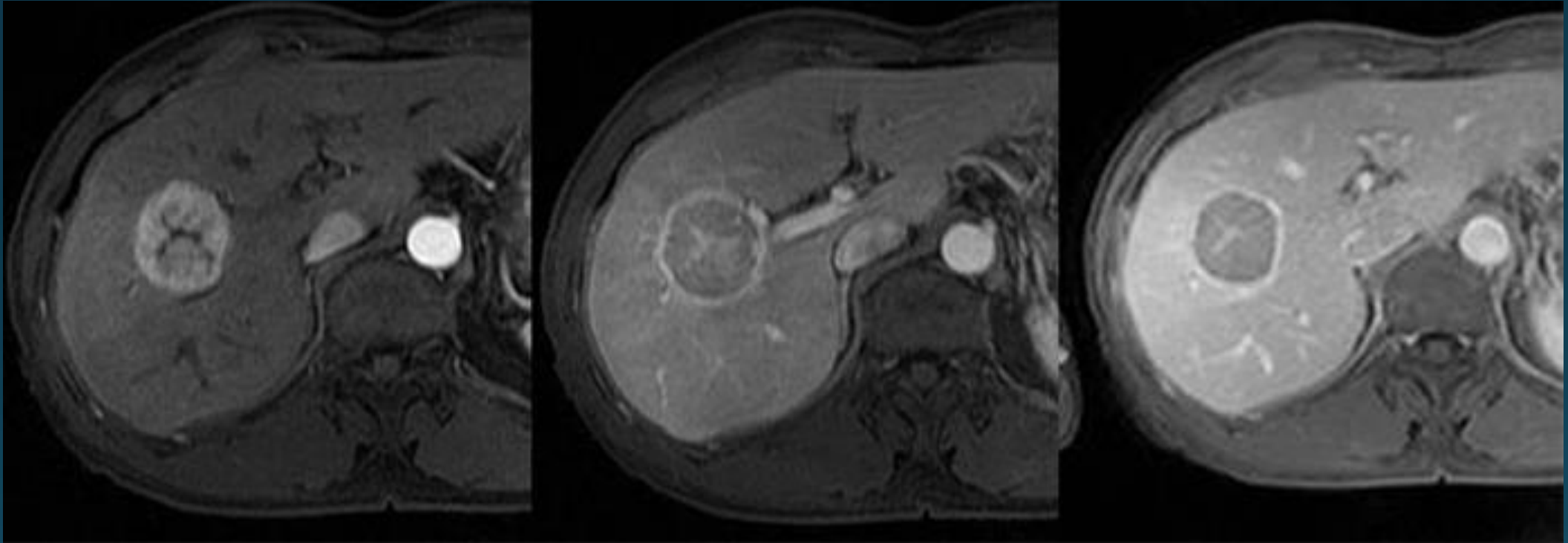


# Hepatocellular carcinoma (HCC)

- T<sub>1</sub> + T<sub>2</sub> varied signal intensity
- Tumour capsule can appear hypointense
- Diffusion restriction
- Heterogeneous enhancement in arterial and later phases



# Hepatocellular carcinoma (HCC)



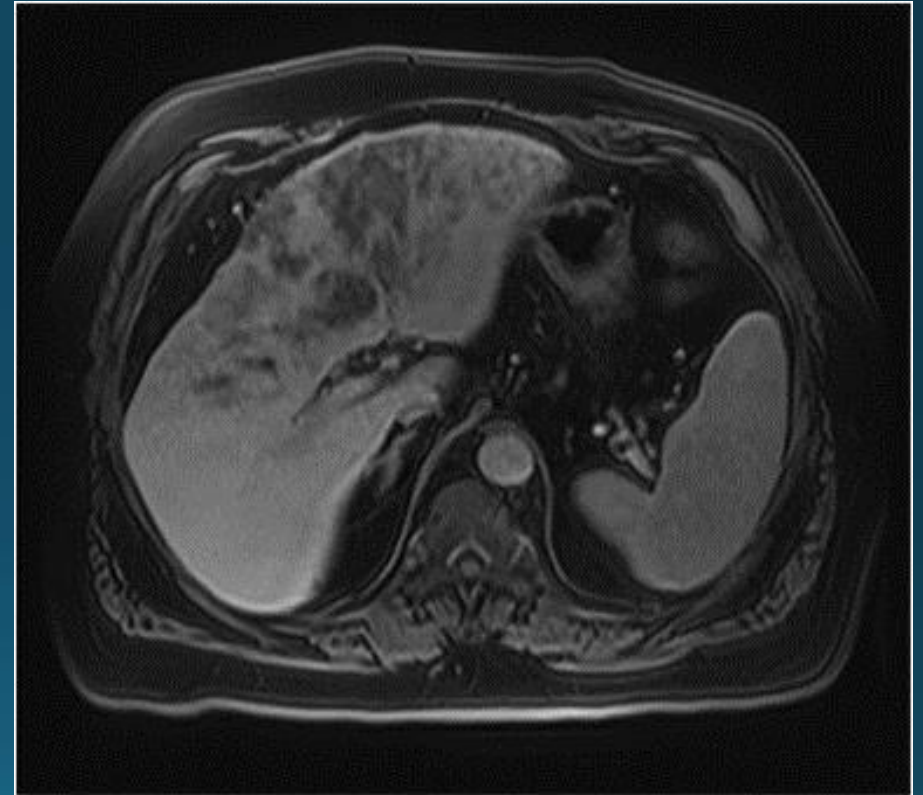
Arterial phase

Portal venous phase

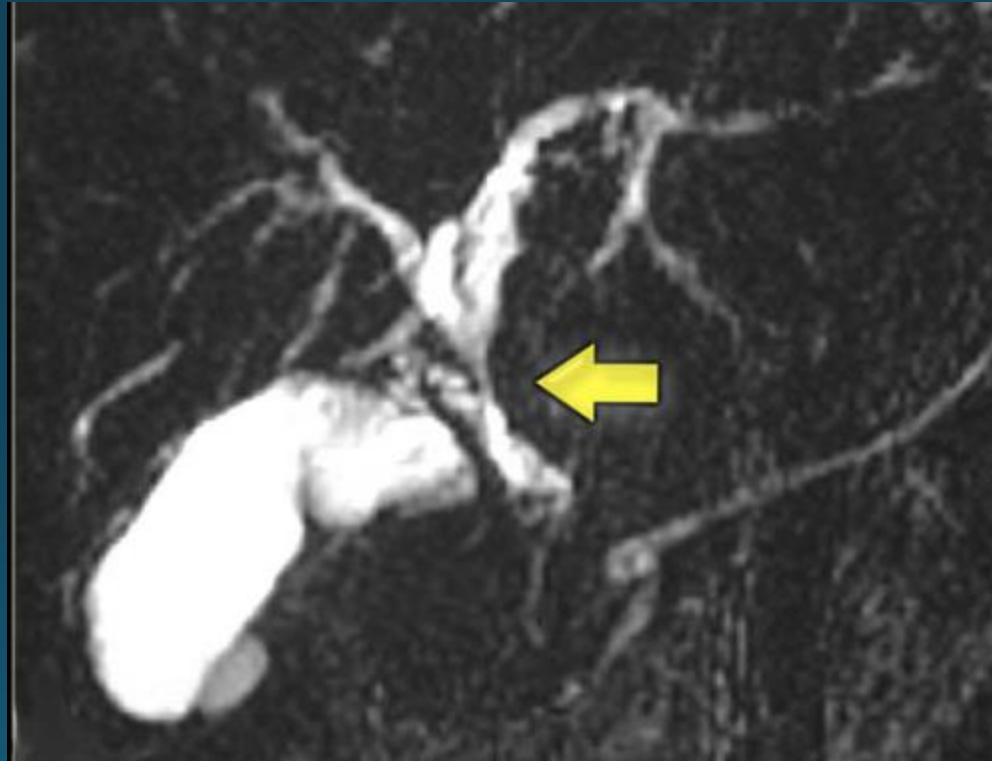
Equilibrium phase

# Cholangiocarcinoma

- MR appearances similar to HCC
- MR cholangiopancreatography (MRCP) may provide further information
- Identify area of stricture



# Cholangiocarcinoma

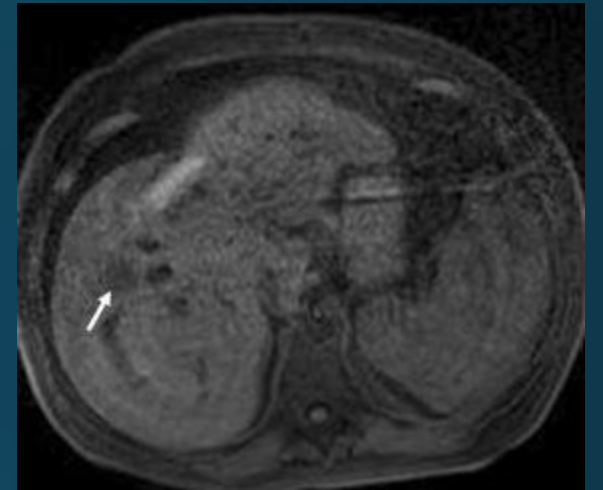


T2 space MRCP MIP

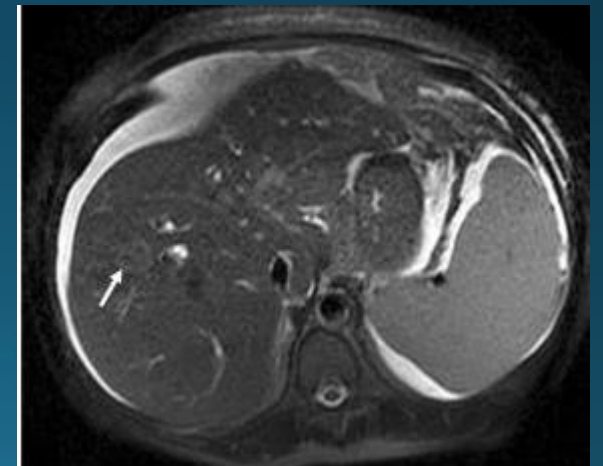
Levy (2009)

# Metastatic lesions

- Most common liver lesions
- Appearance variable – dependant on primary
- T<sub>1</sub> hypo- to isointense
- T<sub>2</sub> Iso- to hyperintense
- Decrease signal at higher TE values
- Diffusion restriction with differences in ADC values compared to parenchyma



T<sub>1</sub>



T<sub>2</sub>

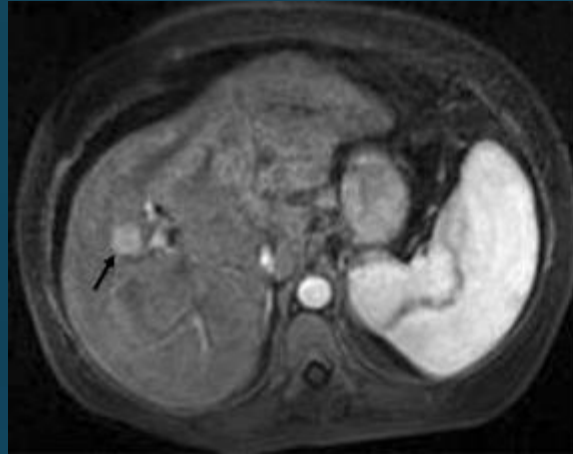
# Metastatic lesions

- Liver-specific contrast media used
- Longer temporal imaging window
- Can be hyper or hypovascular - dependant on primary
- Hypervascular - peak enhancement during arterial phase
- Hypovascular – conspicuous in portal venous phase
- May be cystic
- Can contain haemorrhage (T<sub>1</sub> hyperintense)
- Halo effect

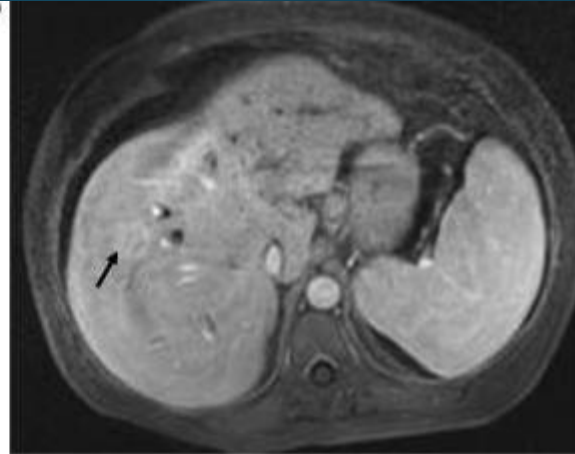


Hypervascular

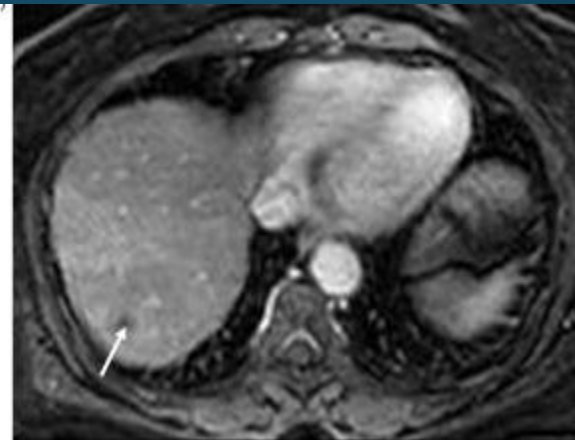
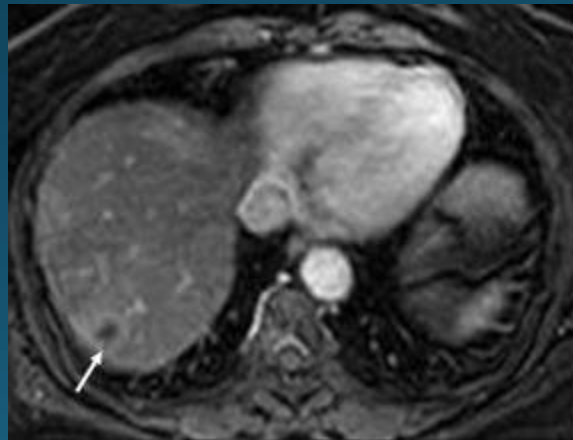
Arterial



Portal venous



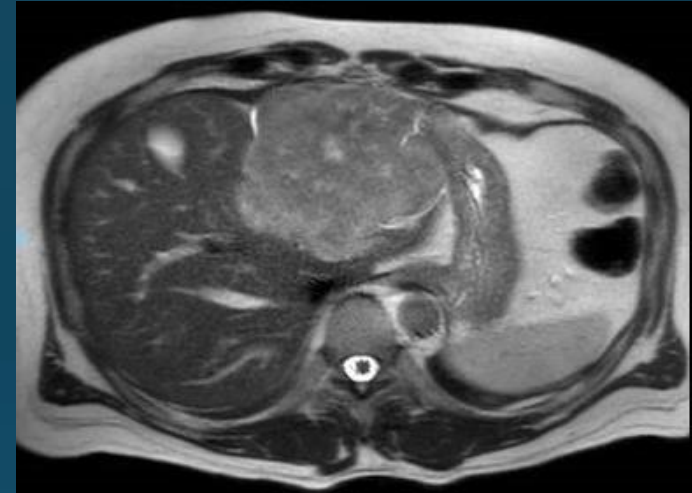
Hypovascular



# Metastatic lesions

- 48 year old male
- Presented with change in bowel habit
- Colonoscopy reveals rectal cancer
- Restaging scans found liver metastases

T2

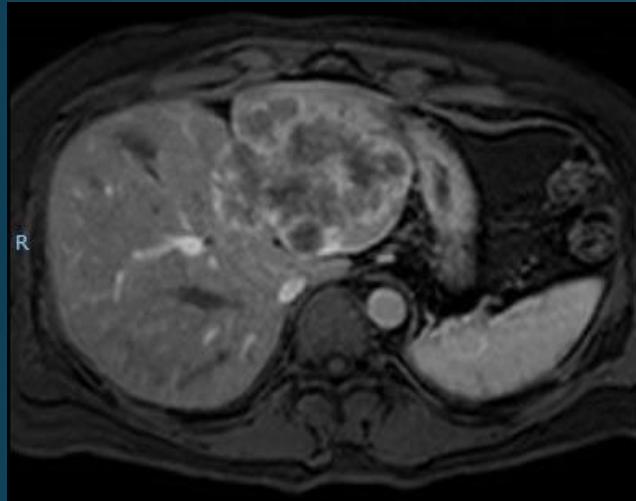


T2 long TE

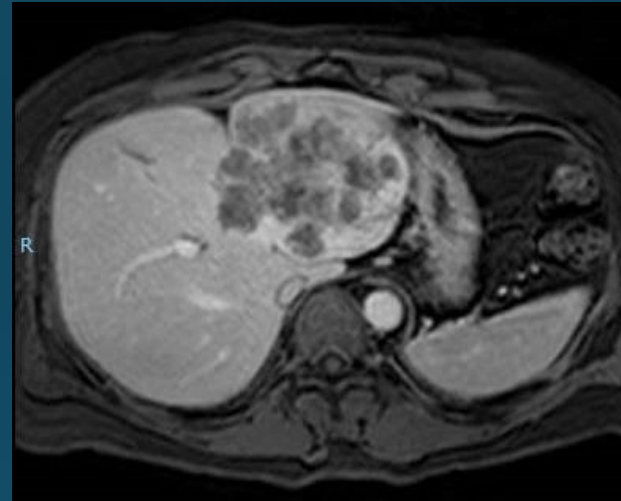


# Metastatic lesions

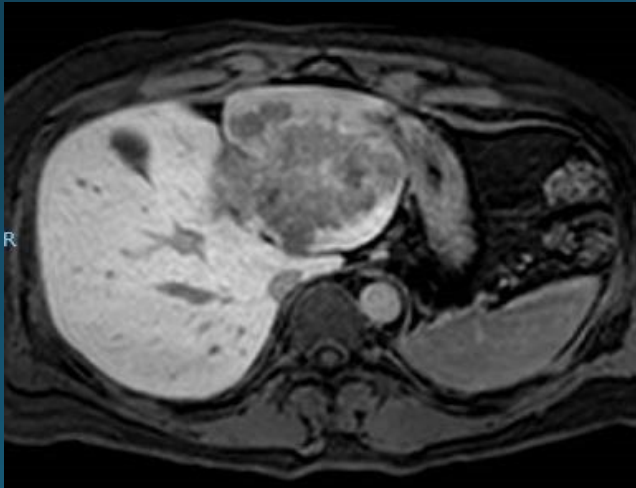
Arterial



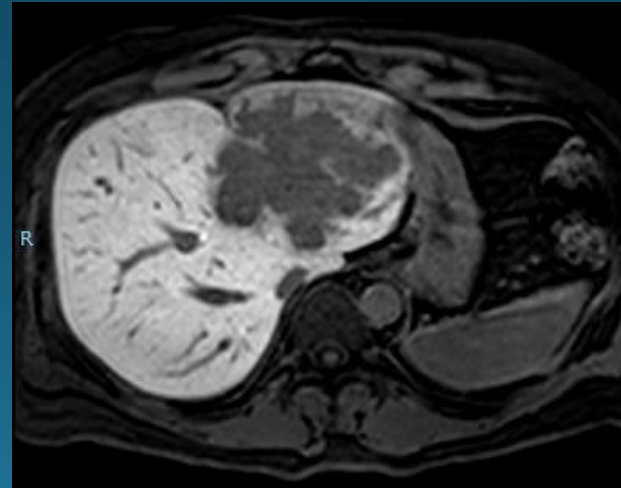
Portal venous



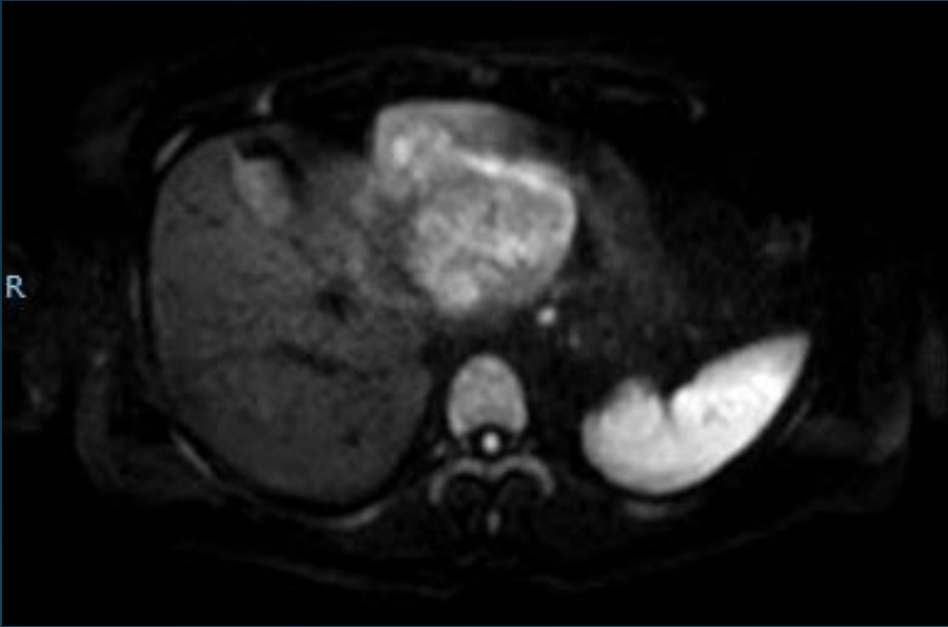
5 minute



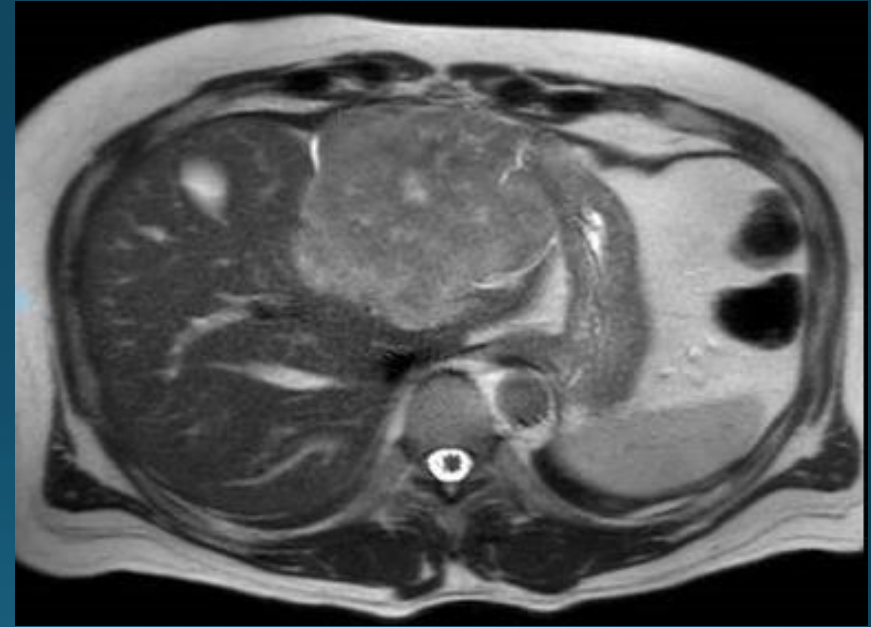
20 minute delayed



# Metastatic lesions

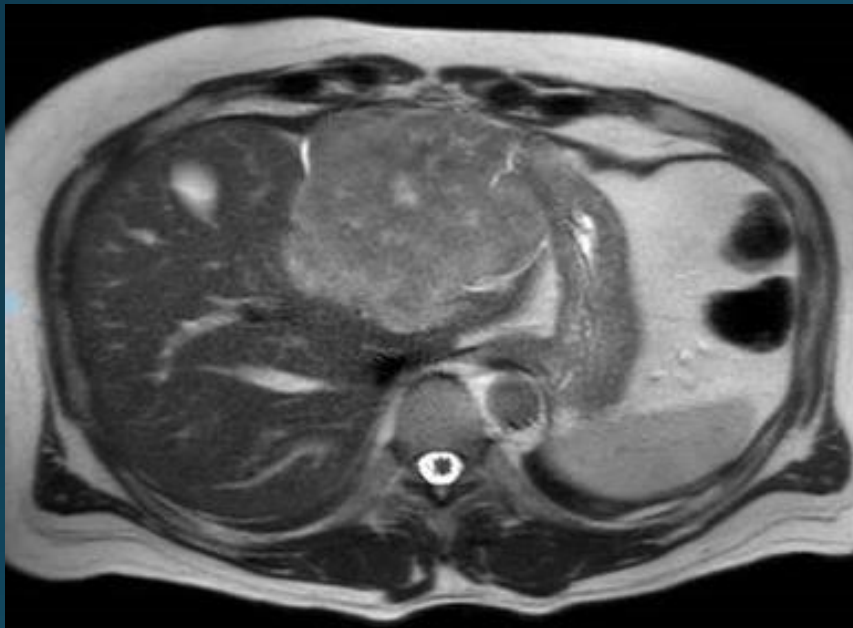


DWI



T<sub>2</sub>

# Metastatic lesions



2016



2017

# Role of MRI

- Non-invasive
- Diagnose
- Characterise
- Staging of disease
- Response to therapy
- Screening of high risk patients

# References

- Albiin N. MRI of focal liver lesions. *Current Medical Imaging Reviews*. 2012;8(2):107-116
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