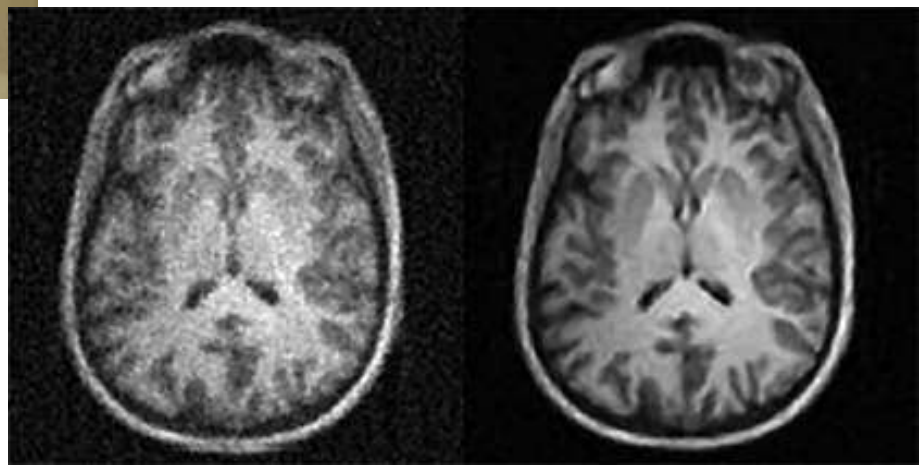
MAGNETIC RESONANCE IMAGING (MRI)

BASICS AND APPLICATIONS



Dr. Anchal Gupta
Lecturer ,Deptt. of RadioDiagnosis
GMC Jammu

INTRODUCTION

- MRI is a technique in radiology which uses magnetism, radio waves and a computer to produce images of body structures.
- Human body is mainly composed of fat and water, which makes the human body composed of about 63% hydrogen, a proton that forms the basis of MRI scanning.

COMPONENTS

- A magnet which produces a very powerful uniform magnetic field.
- RF Coils to transmit radio frequency.
- A very powerful computer system, which translates the signals transmitted by the coils.

PRINCIPLE OF MRI

-Spinning Atoms (hydrogen) face outside magnetic field.

-Energy Absorption by RF Coils.

-Resonance of Hydrogen atoms Measured by RF antenna which the received signal is sinusoidal in shape.

-Imaging by The computer which receives mathematical data, which is converted through the use of a Fourier transform into an image.

HOW DOES THE MRI WORK

- Put subject in big magnetic field.
-Transmit radio waves into subjects.
-Receive radio waves that has been retransmitted by the subject.
-Store the data &repeat step 2.
-Process raw data to reconstruct images.
-Getting high resolution image.

-When placed in a large magnetic field, hydrogen atoms have a strong tendency to align in the direction of the magnetic filed

- Inside the bore of the scanner, the magnetic field runs down the center of the tube in which the patient is placed, so the hydrogen protons will line up in either the direction of the feet or the head.

- The majority will cancel each other, but the net number of protons is sufficient to produce an image.

Kind of images

- T1WI
- T2WI
- PDWI
- DWI
- ADC
- GE
- Perfusion images
- fMRI
- BOLD images
- MRA
- MRV
- Post-Gd images
- Volumetric images
- MR arthrograms
- FLAIR
- STIR

Basic scans

T1WI

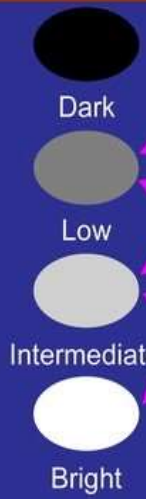
Air, mineral rich tissue (cortical bone, stones), fast-flowing blood

Collagenous tissue (ligaments, tendons, scars), high free water tissue (kidneys, gonads, edema, fluids [urine, bile], simple cysts, bladder, gallbladder, spleen, CSF), high bound water tissues (liver, pancreas, adrenals, hyaline cartilage, muscle)

Proteinaceous tissue (abscess, complex cysts, synovial fluid)

Fat, fatty bone marrow, blood products (methemoglobin [metHb]), slow-flowing blood, radiation change, paramagnetic contrast agents

T2WI



Air, mineral rich tissue (cortical bone, stones), fast-flowing blood

Collagenous tissue (ligaments, tendons, scars), bone islands

High bound water tissues (liver, pancreas, adrenals, hyaline cartilage, muscle)

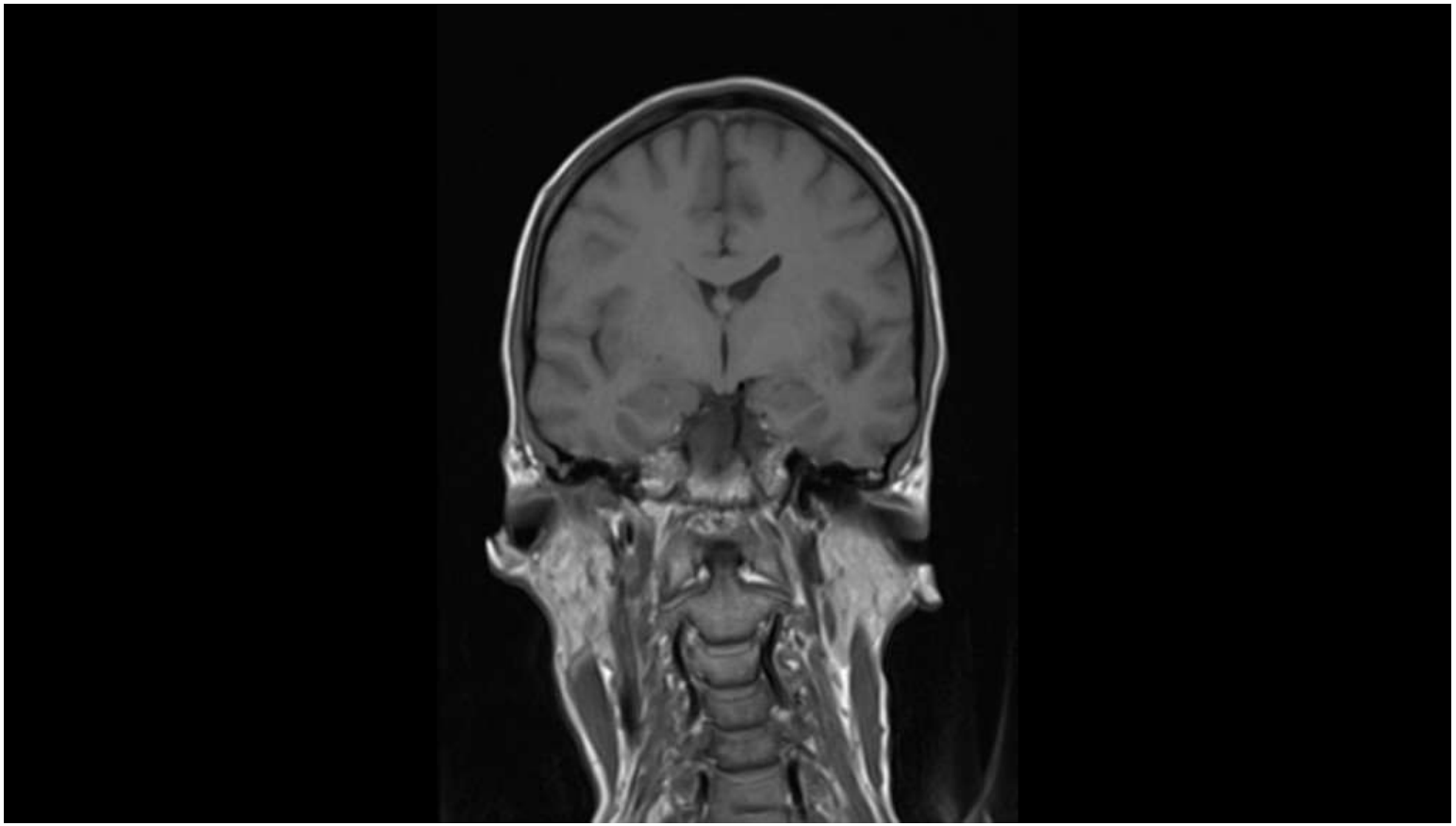
Fat, fatty bone marrow

High free water tissue (kidneys, gonads, edema, fluids (urine, bile), simple cysts, bladder, gallbladder, spleen, CSF), proteinaceous tissue, blood products (oxyhemoglobin, extracellular metHb)

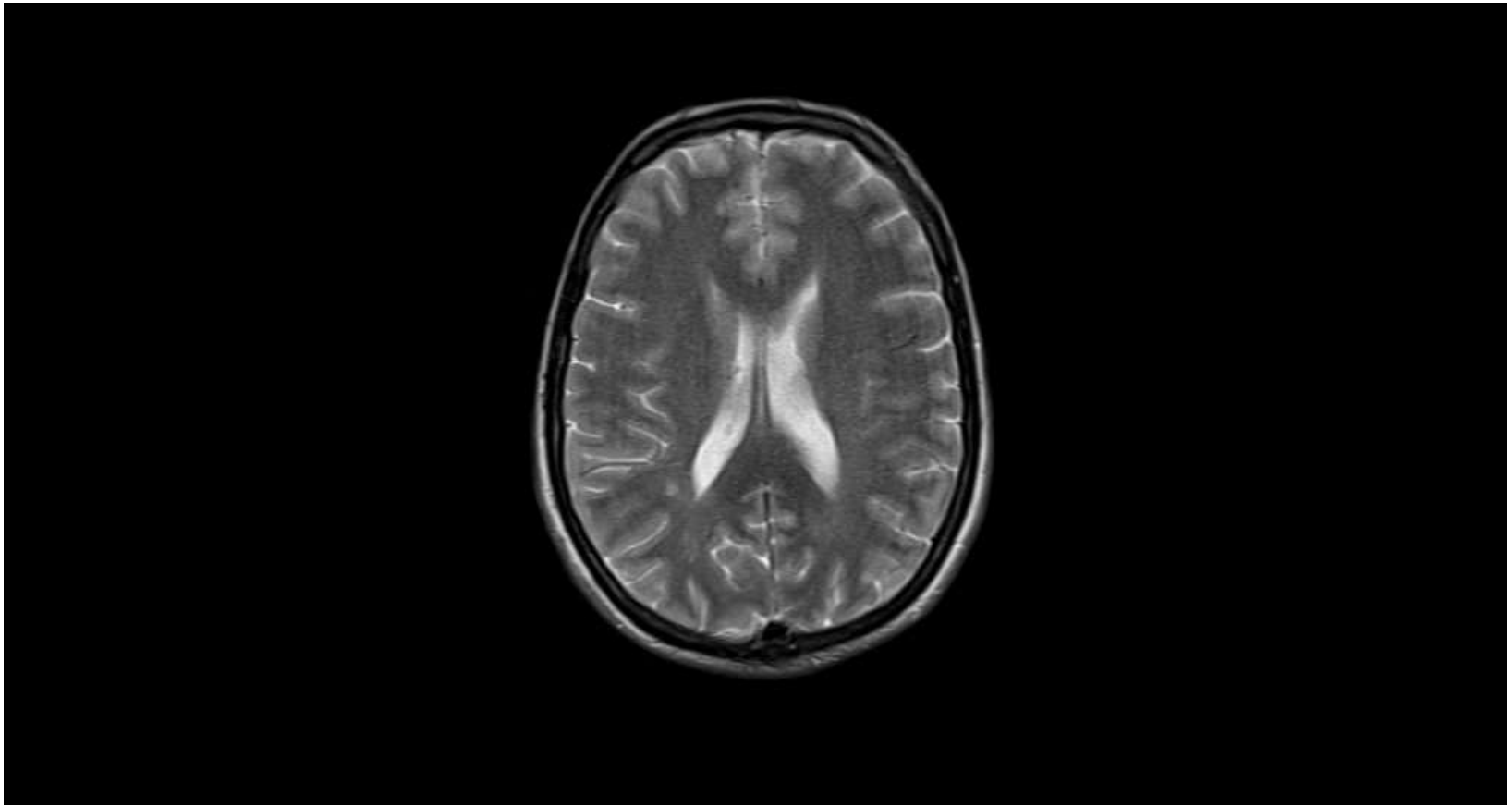
Tissue Appearance

WT	FAT	H2O	MUSC	LIG	BONE
T1	B	D	I	D	D
Proton Density	I	I	I	D	D
T2	I	B	I	D	D

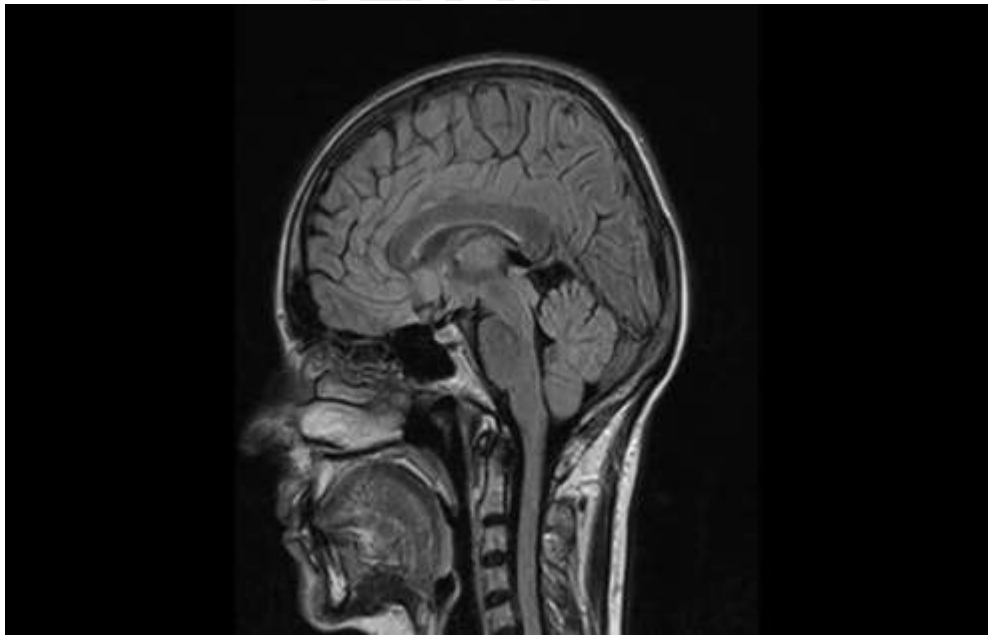
T1WI



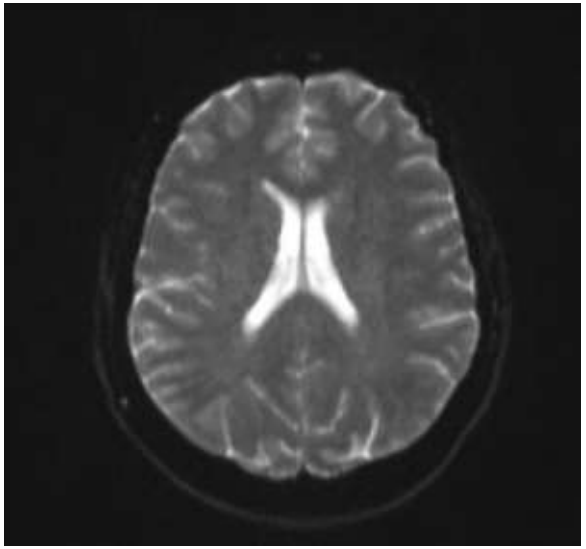
T2WI



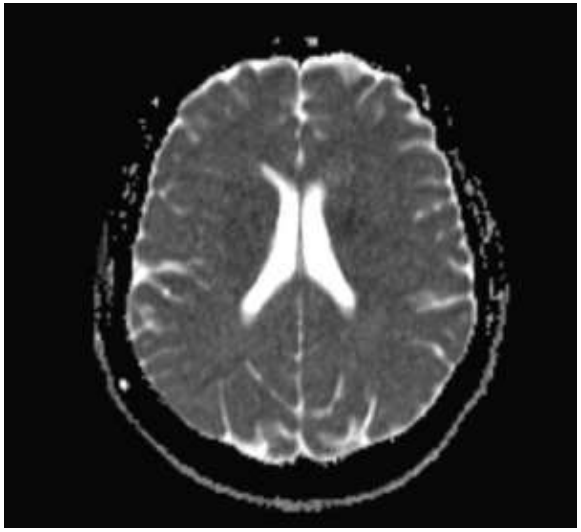
FLAIR



DWI



ADC



Advantages of MRI

1. No ionizing radiation & no short/long-term effects demonstrated
2. Variable thickness, any plane
3. Better contrast resolution & tissue discrimination
4. Various sequences to play with to characterise the abnormal tissue
5. Many details without I.V contrast

Disadvantages of MRI

►Time consuming

►Not easily available (long waiting list),expensive

►No on-call service

►Need to tweak sequences as per the clinical questions; hence cannot be generalised

Pain abdomen - ? cause

MRI has limitations:

Bone

Air

Time consuming

Poor spatial resolution

Expertise!

Known potential safety concerns due to large static magnetic field:

-Internal cardiac pacemakers
-Steel cerebral aneurysm clips (ferromagnetic)
-Small steel slivers embedded in eye
-Life-support equipment with magnetic steel
-Cochlear implants
-Stents anywhere in the body

-Malfunction: ICDs, neurostimulators, bone growth stimulators (prosthetic heart valves)
-Superficial burns (uninsulated wire leads)
-NEED sedation: infants, younger peds, agitated adults (claustrophobia)
- Precautions: magnetic plastic cards, watches, hearing aids, ferromagnetic steel objects

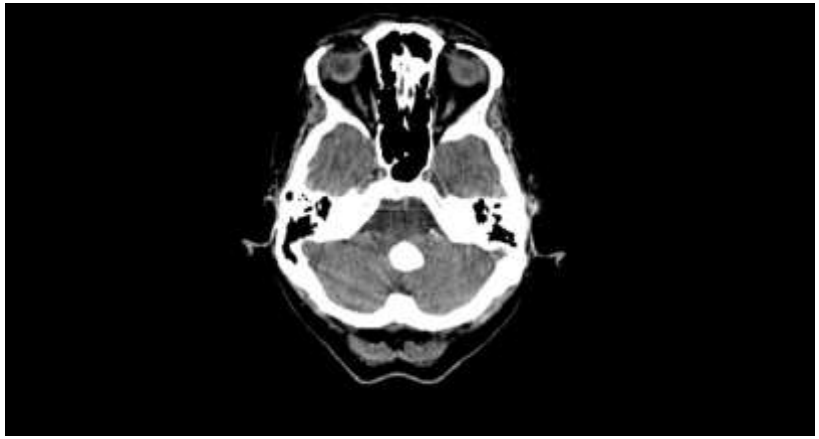
APPLICATIONS OF MRI

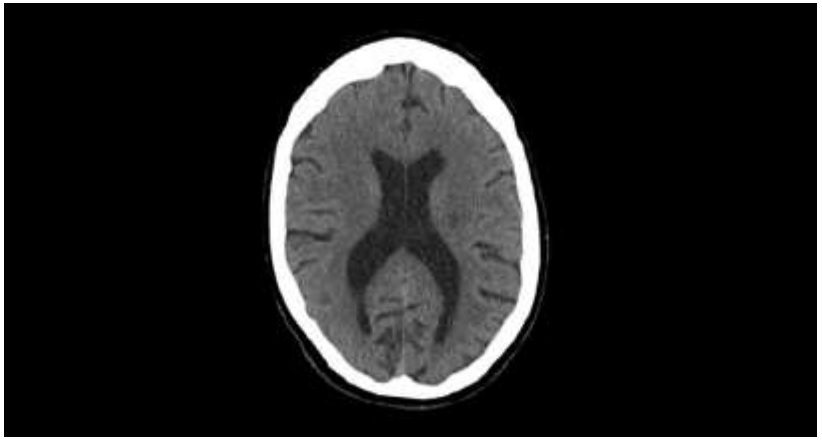
NEUROIMAGING

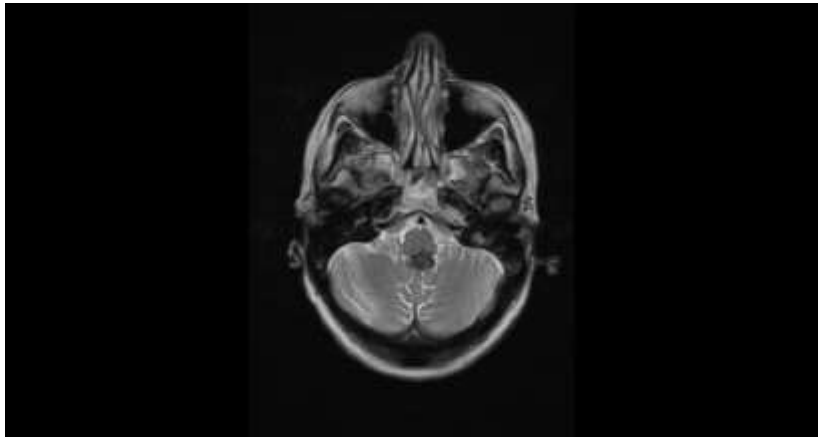
Indications

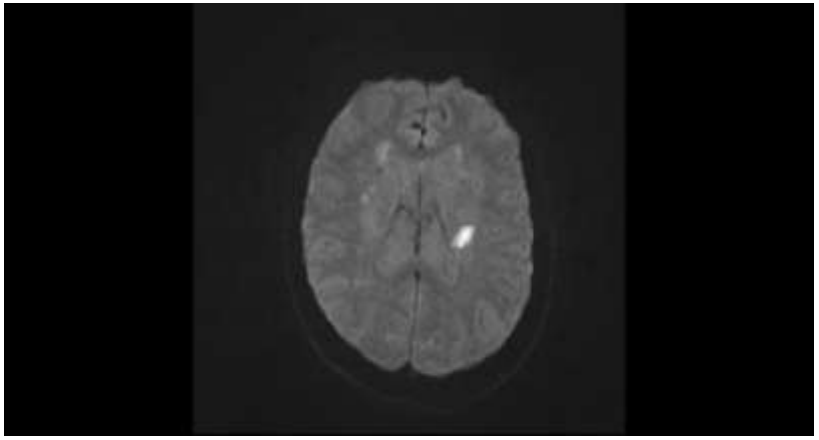
- Anatomy
- Congenital anomalies
- Hereditary and metabolic diseases
- Infections
- Demyelination
- Vascular event
- Tumours
- Trauma
- Dementia
- Hydrocephalus
- Cranial nerves
- Arteriograms
- Venograms
- Skull base
- Pituitary gland

Acute infarct best shown on DWI









Spine imaging

►MR is the investigation of choice

►Conventional CT, CT myelogram and conventional myelogram are no longer performed, unless MR is contraindicated.

►Indications and contraindications – same

►First line of investigation in suspected spinal infection, cord compression, cauda equina, sciatica.

Metastasis

Head and Neck imaging

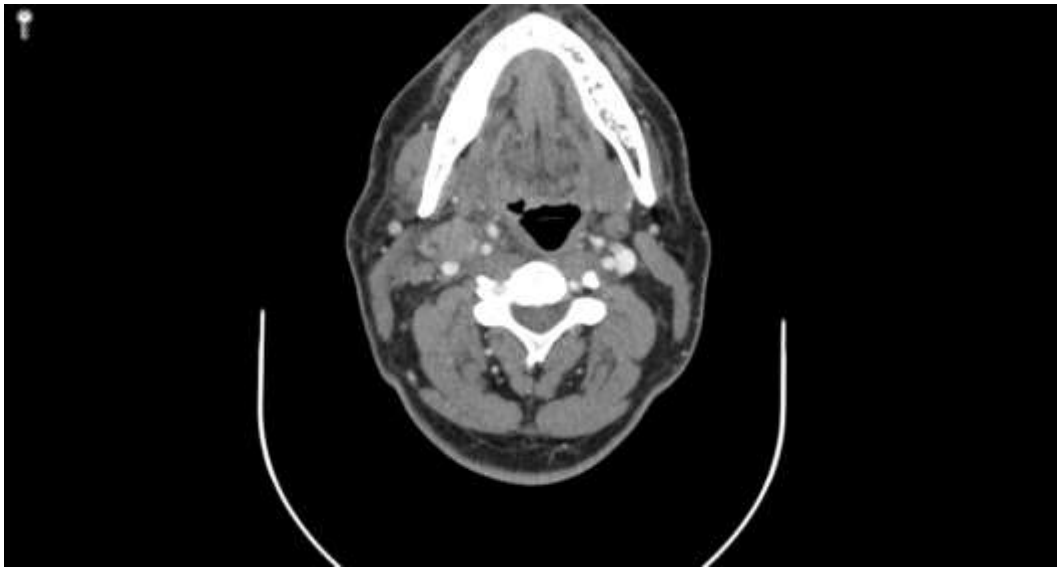
► MR is complementary or second line of investigation in many of head and neck pathologies

► Superior to CT in staging head and neck malignancies

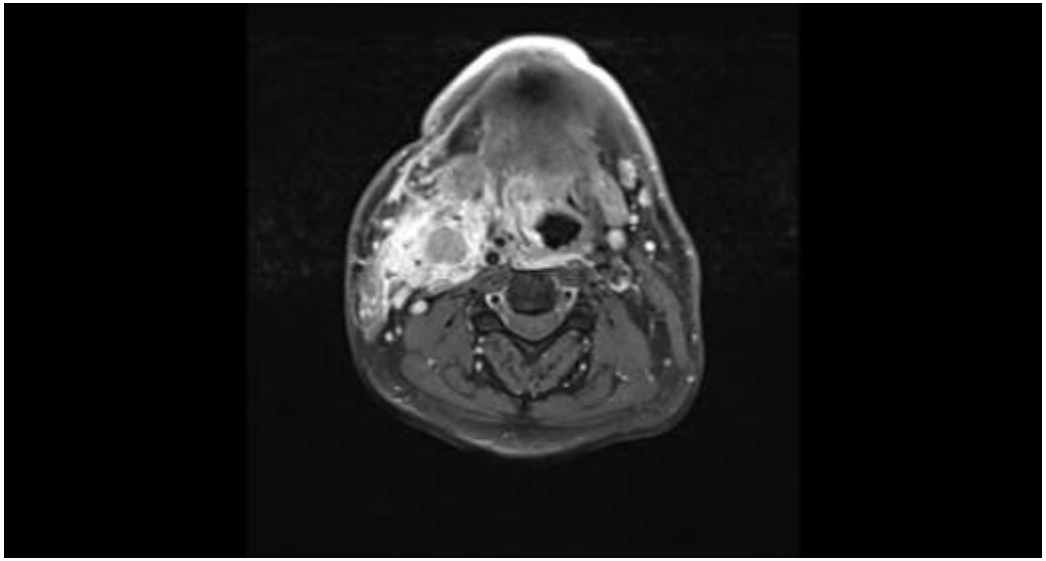
► Characterise the head and neck lesions better than
CT

► Complementary to CT in petrous temporal and paranasal sinus evaluation

► First line of investigation in orbital lesions



Tongue base carcinoma



Musculoskeletal imaging

►Initial evaluation of bones – Plain films; then MRI

►MRI sensitive than CT in diagnosing occult fractures

►Initial evaluation of soft tissues – USG; then MRI

►Joint imaging = MRI

Indications

- Occult fractures
- Marrow abnormality
- Ligament pathologies
- Tendon pathologies
- Muscular injuries
- Infection
- Bone and soft tissue tumour
- Labral pathologies

Avascular necrosis

Abdominal MRI

►Problem solving tool in liver, pancreatic, renal and adrenal lesions

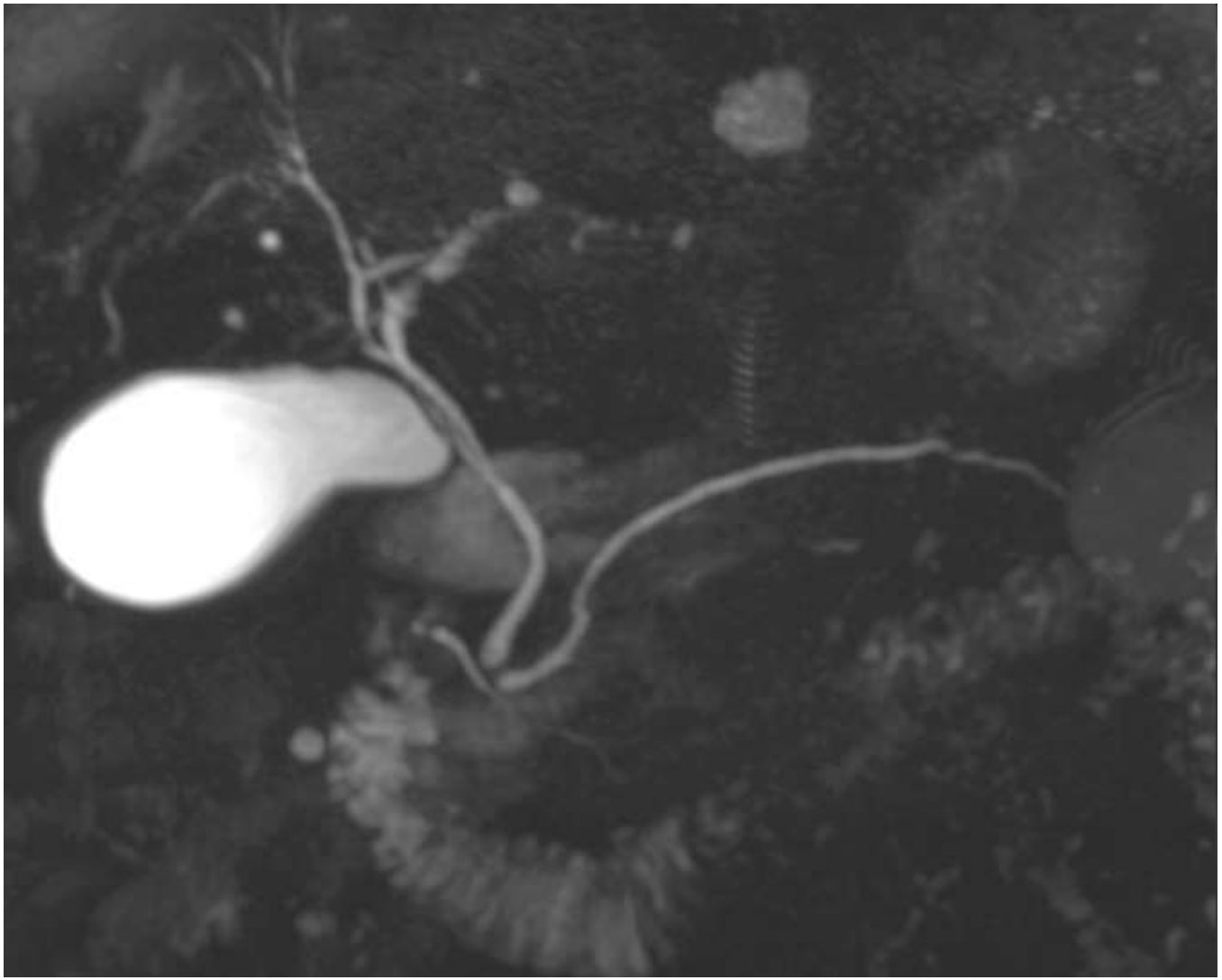
►Primary modality in local staging of rectal ca, endometrial ca, cervical ca, prostate ca, vaginal ca

►Non-invasive modality in evaluating pancreaticobiliary tract – MRCP

►Scrotal and penile imaging

►Uterus and ovary imaging

MRCP



Vascular MRI

-Peripheral vascular arteriogram with or without I.V contrast...

-Aortogram

-Dissection

-Pulmonary arteriogram

-When CT is contraindicated

Cardiac MRI

►Coming in a big way

►Very useful in congenital heart diseases, cardiomyopathies

►Evidence is emerging in the evaluation of myocardial infarction

Breast MRI

- ►Problem solving
- ► Breast implants
- ► Recurrence
- ► Multifocal disease

Foetal MRI

- ►Assessment of congenital anomalies
- ►Placental abnormalities
- ►Twin assessment

Summary

►Expensive time-consuming investigation
►Complex physics, too many sequences, difficult to interpret to untrained eyes
►Relatively safe, but there are definite contraindications
►Ask specific question to get the right answer
►MRI invaluable imaging tool in the diagnosis of various diseases from head to toe
►Chief modality in neuroimaging, and musculoskeletal imaging
►Problem solving tool in abdominal pathologies
►Invaluable tool in local staging of most of the malignancies