Al-Mustaqbal University
College of Health and Medical Technologies
Radiological Techniques Department

Magnetic Resonance Imaging

First Semester

Lecture 13,14 : MRI of the brain & Pituitary

By

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Introduction :

Understanding brain MRI imaging is essential for MRI technologist to perform MRI exams effectively, interpret MRI results accurately, optimize MRI parameters, and keep up-to-date with MRI technology. Brain MRI imaging can provide information about the brain's anatomy, detect abnormalities, and measure blood flow and diffusion in the brain. MRI technologist can learn about brain MRI imaging through MRI tech programs, continuing education courses, and on-the-job training.

Scientific Content:

Common indications

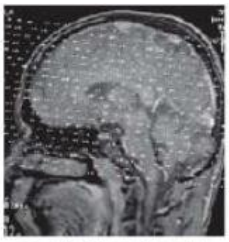
- MS
- Primary* tumour assessment and/or metastatic disease
- AIDS (toxoplasmosis)
- Infarction (cerebral vascular accident (CVA) versus transient ischaemic attack (TIA))
- Haemorrhage
- Hearing loss
- Visual disturbances
- Infection
- Trauma
- Unexplained neurological symptoms or deficit
- Preoperative planning
- Radiation treatment planning
- Follow-up (surgical or treatment)

Equipment

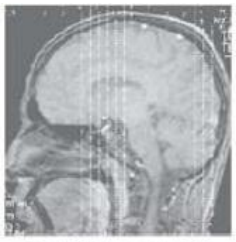
- Head coil (quadrature or multi-coil array)
- Immobilization pads and straps
- Earplugs/headphones
- High-performance gradients for EPI, diffusion and perfusion imaging..

Patient positioning

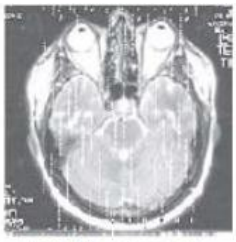
The patient lies supine on the examination couch with their head within the head coil. The head is adjusted so that the inter-pupillary line is parallel to the couch and the head is straight. The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the nasion. Straps and foam pads are used for immobilization.



Sagittal localizer to obtain axial slices



Sagittal localizer to obtain coronal slices



Axial localizer to obtain sagittal slices

Main MRI sequences of the brain

1- Tl-Weighted Axial Imaging:

Parameters:

Slice thickness: 5-6 mm

Use: Provides detailed anatomical information of the brain, helps in detecting tumors, and is often used as a baseline for post-contrast imaging.

2- T2-Weighted Axial Imaging:

Parameters:

Slice thickness: 5-6 mm

Use: Highlights lesions, edema, and cysts. Good for detecting white matter diseases and brain abnormalities.

3- Tl-Weighted Coronal Imaging:

Parameters:

Slice thickness: 5-6 mm

Use: Provides a different perspective of brain anatomy, especially useful for assessing the pituitary gland and other coronal structures.

4- Fluid-Attenuated Inversion Recovery (FLAIR) Imaging:

Parameters:

Slice thickness: 5-6 mm

Use: Suppresses CSF signal and enhances lesion visibility, helpful in detecting multiple sclerosis (MS) lesions and vascular abnormalities.

5- Diffusion-Weighted Imaging (DWI):

Parameters:

Slice thickness: 5-6 mm

b-values: Typically, 0 and 1000 sec/mm^2

Use: Detects areas of restricted diffusion, valuable for diagnosing acute stroke and evaluating tissue damage.

6-Diffusion Tensor Imaging (DTI):

Parameters:

Slice thickness: 2-3 mm

Use: Maps white matter tracts, assesses brain connectivity, and studies conditions like traumatic brain injury and white matter diseases.

7-Susceptibility-Weighted Imaging (SWI):

Parameters:

Slice thickness: 1-2 mm

Use: Detects hemorrhages, microbleeds, and venous abnormalities, useful in cases of head trauma and vascular disorders.

8-Functional MRI (fMRI):

Parameters:

Typically includes T2*-weighted or BOLD (Blood Oxygen Level Dependent) sequences.

Use: Maps brain activity and connectivity during tasks or at rest, used in research and for preoperative planning in certain cases.

9-Magnetic Resonance Spectroscopy (MRS):
Parameters:
Acquires spectra from specific regions of interest.
Use: Measures biochemical information about brain tissue, aids in characterizing brain lesions, tumors, and metabolic disorders.

10-Perfusion MRI (pMRI):
Parameters:
Uses dynamic contrast enhancement or arterial spin labeling.
Use: Measures blood flow to assess brain perfusion, valuable in diagnosing and monitoring acute stroke, vasculitis, and tumor response to treatment.

In Summary, these sequences offer a comprehensive view of the brain's structure, function, and blood flow, allowing for the diagnosis and evaluation of various neurological conditions and diseases. The choice of sequences and parameters may vary depending on the clinical indication and the patient's specific needs. Always consult with a medical professional or radiologist for the most appropriate MRI protocol.

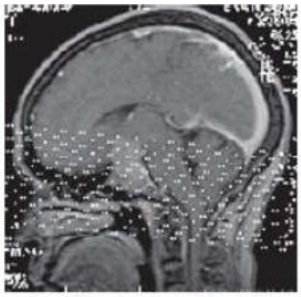
MRI of the Pituitary

Common indications

- Investigation of diseases related to pituitary function (hyperprolactinaemia, Cushing's disease, acromegaly, hypopituitarism, diabetes insipidus, amenorrhea)
- Hypothalamic disorders
- Visual field defect
- Post-operative assessment of pituitary adenomas

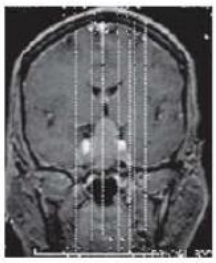
Equipment

- Head coil (quadrature or multi-coil array)
- Immobilization pads and straps
- Earplugs/headphones



Sagittal localizer for axial slices

Sagittal localizer for coronal slices



Coronal localizer for sagittal slices

Main MRI sequences of pituitary

1-Tl-Weighted Axial Imaging:

Parameters:

Slice thickness: 3-5 mm

Use: Provides anatomical details of the pituitary gland and surrounding structures. Useful for detecting pituitary tumors and assessing their size and extension.

2-T2-Weighted Axial Imaging:

Parameters:

Slice thickness: 3-5 mm

Use: Helps in identifying abnormalities with different tissue contrasts. Useful for visualizing cystic or hemorrhagic changes in pituitary lesions.

3-Tl-Weighted Post-Contrast Imaging:

Parameters:

Slice thickness: 3-5 nun

Contrast agent: Gadolinium-based contrast agent

Use: Enhances the visibility of pituitary lesions by highlighting areas of contrast uptake. Particularly useful for detecting pituitary adenomas and assessing their characteristics.

3-Thin-Slice Dynamic Contrast-Enhanced Imaging:

Parameters:

Slice thickness: 1-2 nun Temporal resolution: 2-5 seconds

Contrast agent: Gadolinium-based contrast agent

Use: Evaluates the vascularity and blood flow of pituitary lesions over time, aiding in distinguishing between different types of pituitary tumors.

4-Fat-Suppressed Imaging:

Parameters:

Slice thickness: 3-5 mm

Use: Helps differentiate between fat and non-fat components within pituitary lesions, assisting in characterizing lesions such as craniopharyngiomas.

5-3D Volumetric Imaging:

Parameters:

High-resolution isotropic imaging

TR and TE similar to T1-weighted sequences

Use: Provides a three-dimensional view of the pituitary gland and surrounding structures, allowing for precise localization and assessment of lesions.

6-Diffusion-Weighted Imaging (DWI):

Parameters:

Slice thickness: 3-5 mm

b-values: Typically 0 and 1000 sec/mm^2

Use: May help in characterizing pituitary lesions based on their cellularity and diffusion properties. Can be useful in differentiating pituitary adenomas from other lesions.

7-Magnetic Resonance Spectroscopy (MRS):

Parameters:

Single-voxel or multi-voxel spectroscopy

Use: Measures chemical composition within the pituitary gland, assisting in distinguishing between different types of pituitary lesions based on their metabolic profiles.

These MRI sequences and parameters provide a comprehensive evaluation of the pituitary gland, helping to diagnose and characterize various pituitary disorders, including adenomas, cysts, and other lesions. The choice of sequences may vary based on clinical indications and the suspected pathology. Always consult with a radiologist or healthcare provider for the most appropriate pituitary MRI protocol.