Different Types of Brain MRI Sequences and What They Show

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If you are new to looking at Brain MRI scans, you may have difficulty understanding the different sequences and what each sequence is used for clinically. This is a quick reference article to assist!

CSF signal intensity for different brain MRI sequences

T1-Weighted: CSF appears dark (hypointense).

T2-Weighted: CSF appears bright (hyperintense).

T2 FLAIR: CSF is suppressed and appears dark.

DWI: CSF appears dark, similar to T2 FLAIR.

SWI: CSF appears dark.

T2*: CSF appears dark.

Lesion appearance in different brain MRI sequences

T1-Weighted: Lesions such as tumours can appear hypointense or isointense; post-contrast T1 can show enhancement of certain lesions.

T2-Weighted: Lesions are hyperintense (bright) but may be less distinct near bright CSF.

T2 FLAIR: Lesions are hyperintense (bright) and more conspicuous against the dark CSF.

DWI: Acute lesions (e.g., infarcts) show hyperintensity due to restricted diffusion.

SWI: Lesions containing blood products, calcium, or other paramagnetic substances appear very dark (hypointense). Useful for detecting microbleeds, haemorrhagic lesions, and calcifications.

T2*: Lesions with blood products, calcium, or iron deposits appear very dark (hypointense), similar to SWI. Useful for detecting microbleeds, calcifications, and iron deposits.

Application and clinical utility of different brain MRI sequences

T1-Weighted: Excellent for anatomical detail, cortical anatomy, showing patterns of atrophy, and pre- and post-contrast studies to identify enhancing lesions.

T2-Weighted: Used for general anatomical detail and identifying areas of oedema, tumour, or demyelination, non-neurodegenerative pathology and infratentorial or thalamic infarcts.

T2 FLAIR: Particularly useful for identifying lesions near CSF spaces (e.g., periventricular white matter lesions in MS).

DWI: Primarily used to detect acute ischemic strokes and differentiate between cytotoxic oedema (restricted diffusion) and vasogenic oedema (normal or increased diffusion).

SWI: Excellent for detecting microhemorrhages, calcifications, and venous structures. Used in trauma cases, cerebrovascular disease, and brain tumours.

T2*: Similar to SWI, useful for detecting microbleeds, calcifications, and iron deposits. It is often used to assess haemorrhagic lesions and to evaluate for certain neurodegenerative diseases.

Ventricular appearance in different brain MRI sequences

T1-Weighted: Ventricles are dark due to low CSF signal.

T2-Weighted: Ventricles are bright due to high CSF signal.

T2 FLAIR: Ventricles are dark due to suppressed CSF signal.

DWI: Ventricles appear dark, similar to T2 FLAIR.

SWI: Ventricles are dark. The focus is on detecting susceptibility differences rather than CSF signal.

T2*: Ventricles are dark. The focus is on detecting susceptibility differences.

Tips to differentiate brain MRI sequences

CSF Signal

- **Bright:** Likely T2-weighted.
- **Dark:** Could be T1-weighted, T2 FLAIR, DWI, SWI, or T2*

Lesion Characteristics

- **Hypointense Lesions Post-Contrast:** T1-weighted.
- **Hyperintense Lesions with Bright CSF:** T2-weighted.
- **Hyperintense Lesions with Dark CSF:** T2 FLAIR.
- **Hyperintense Acute Lesions (Restricted Diffusion):** DWI.
- **Hypointense Lesions (Blood/Calcium):** SWI or T2*.

Clinical Context

- **Anatomic Detail and Enhancing Lesions:** T1-weighted.
- **General Anatomic and Pathologic Survey:** T2-weighted.
- **Detailed Lesion Identification Near CSF:** T2 FLAIR.
- **Acute Infarct Detection:** DWI.
- **Microbleeds, Haemorrhagic Lesions, and Calcifications Detection:** SWI or T2*.

Visual examples of different brain MRI sequences

- **T1-Weighted Image:**
  - CSF Dark.
  - Lesions vary; post-contrast can show enhancement.
- **T2-Weighted Image:**
  - CSF Bright.
  - Less distinct periventricular lesions.
- **T2 FLAIR Image:**
  - CSF Dark.
  - Clear periventricular and cortical lesions.

- **DWI Image:**
  - CSF Dark.
  - Acute lesions show hyperintensity due to restricted diffusion.
- **SWI Image:**
  - CSF Dark.
  - Microbleeds (small round dark spots), haemorrhagic lesions, and calcifications appear very dark (hypointense).
- ***T2* Image:***
  - **CSF:** Dark
  - **Lesions:** Hypointense for blood, calcium, and iron deposits, similar to SWI.

Summary

- **T1-Weighted:** Dark CSF, useful for anatomical detail, cortical anatomy, and post-contrast enhancement.
- **T2-Weighted:** Bright CSF, useful for general pathology.
- **T2 FLAIR:** Dark CSF, excellent for periventricular and cortical lesion visualization.
- **DWI:** Dark CSF, highlights acute ischemic changes due to restricted diffusion.
- **SWI:** Dark CSF, highlights microbleeds, haemorrhagic lesions, and calcifications due to susceptibility differences.