ROLE OF NEUROIMAGING IN OPTIMIZING EPILEPSY CARE

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OUTLINE
• Role of Imaging in Epilepsy
• Indication of Imaging
• Imaging Modalities and Updates

Role of Imaging
• Pre-surgery
  – Identify structural abnormality
  – Localize
• Plan for surgery
  – Help confirm epileptogenicity
  – Relationship with eloquent areas
  – Predict resectivity and Prognostication
• Post-surgery
  – Evaluate residual lesion
  – Surveillance

Goal of Epilepsy Care
• Seizure free
• Acceptable quality of life

Treatment
• Medication
• Surgery
  ➔ How to select patient?
• Psychosocial support and Rehab

How?
• Find patients who will get the most benefit and lowest treatment-related complication.

MEDICATION

SURGERY
**Epilepsy**

**Medication**

**Surgery**

**Clinical & Electrophysiologic diagnosis**

**Identify and Locate Structural Abnormality**

**Clinical**

**Imaging**

**Surgery**

**Localization-related Epilepsy**

**Ideal Imaging**

- Distinguish abnormal from normal -> **High resolution**
- Tell etiology/nature of abnormality -> **Good Characterization**
- Allow assessment of relationship with eloquent structures -> **Functional/Microstructural derangement**
- Evaluate epileptogenicity -> **Physiologic data**

**Reality**

- No single method can do all

  - Combine data from multiple sources
  - Multimodal imaging co-registration

**Type of Imaging**

- **Anatomy**

- **Physiology and Function:** SPECT, PET, MEG, MRS, DTI, fMRI, Perfusion CT/MRI
**Etiologies/Epileptogenic Substrates Identifiable with MRI**

**PEDIATRIC**
- Birth-related
- Congenital Malformation
- Inborn-error of metabolism
- Neoplasm
- Infection
- Post trauma
- Vascular (malformation)
- MTS

**ADULT**
- Vascular (Stroke, AVM, cavernoma)
- Tumor (primary and mets)
- MTS
- Prior brain injury

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**TO MAXIMIZE MRI SENSITIVITY**

- Appropriate MRI Protocol
- High performance MRI equipment
- Updated software
- Experienced (Neuro)radiologist

Clinical History, EEG finding

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**EPILEPSY MRI MNEMONIC**

- **H**ippocampal size and signal
- **I**AC & atrium (check correct plane and positioning)
- **P**eriventricular heterotopia
- **P**eripheral
  - Sulcal morphology abnormality
  - Atrophy
  - Gray matter thickening
  - Encephalocele
- **O**bvious lesion

**HIPPO SAGE**

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**ADD-ON MRI SOFT-WARES**

- Volumetry
- T2 Relaxation calculation
- SISCOM

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**Conventional MRI: Pros**

- Good spatial resolution
- Soft tissue contrast
- Multiplanar
- No ionizing radiation
- Continuous development of techniques and softwares
Conventional MRI: Cons

- Long Imaging time
- Contraindications:
  - Cardiac pacemaker, intracranial aneurysm clip, cochlear implant
  - Poor renal function...Gd
  - Attention deficit, mental disability
  - Claustrophobia
- Cannot assess epileptogenicity or functionality

CT: Indication

- Emergency or First unprovoked seizure with neurologic abnormality
- CT results change management in patients with acute seizure.
- For refractory seizures: MRI sensitivity 95% CT sensitivity 32%

Solution for MRI Negative

Combine data from multiple sources

Multimodal imaging co-registration

Physiologic Imaging

- Anatomy: MRI
- Physiology and Function: SPECT, PET, MEG, MRS, DTI, fMRI, Perfusion CT/MRI

- PET
  - FDG PET
Emerging Imaging Techniques

- MEG (MagnetoEncephaloGraphy) & MSI (Magnetic Source Imaging)
  - Localize epileptogenic substrate
  - Evaluate functioning cortex
Emerging Imaging Techniques

DTI in Epilepsy Imaging

Research
- Assess epileptogenic zone in LRE
- DTI abnormality (Decreased FA) in TLE in ipsilateral brain

Emerging Imaging Techniques

- BOLD (Blood Oxygen Level Dependent) fMRI

BOLD Functional cortical mapping

Sensorimotor task: Finger tapping

Emerging Imaging Techniques

- fMRI in Epilepsy Imaging
  - Evaluate functioning cortex/eloquent area: Motor cortex, Language lateralization, Memory
Emerging Imaging Techniques

- 1-H MR Spectroscopy (MRS) in Epilepsy Imaging
  - Lateralization in TLE
    Decreased absolute NAA, Decreased NAA/Choline, NAA/Creatine, NAA/Choline+Creatine ratios
    Ipsilateral to lesion

Emerging Imaging Techniques

- Perfusion CT/MRI
  - Not well established role in epilepsy imaging

Summary: Role of Imaging

- Pre-surgery
  - Identify structural abnormality
  - Localize
- Plan for surgery
  - Help confirm epileptogenicity
  - Relationship with eloquent areas
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Summary: Imaging of choice

<table>
<thead>
<tr>
<th>Emergency</th>
<th>CT</th>
<th>Conventional MRI (Standard protocol)</th>
<th>MRS</th>
<th>SPECT</th>
<th>PET</th>
<th>MEG + MSI</th>
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<tbody>
<tr>
<td>General</td>
<td></td>
<td>Conventional MRI</td>
<td>MRS</td>
<td></td>
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<tr>
<td>- Identify obvious epileptogenic substrates</td>
<td>- Special Protocol</td>
<td>- Experienced radiologist</td>
<td>- DTI</td>
<td>DWI</td>
<td>MRS</td>
<td></td>
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<tr>
<td>Special Attention</td>
<td>- Identify subtle epileptogenic substrates</td>
<td>- Special coil</td>
<td>- 3T &gt; 1.5T</td>
<td>- Special coil</td>
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<tr>
<td>Specific Attention</td>
<td>- Pre-surgical evaluation of risk, potential complications</td>
<td>- Research</td>
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THANK YOU