Neuroimaging in Epilepsy

Where we were and where we are going

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CT Scan in Epilepsy
Pioneering MRI Unit

Raymond Damadian 1977
Epilepsy Neuroimaging Articles (1990 - 2011)

PubMed Search
Lesional Temporal Lobe Epilepsy
Early demonstration of MTS

Kuzniecky et al. Annals Neuro 1987
Hippocampal Sclerosis
Hippocampal Sclerosis Plus

TL Epilepsy based on MRI

Asymmetric - with or without other lesions

Symmetric - usually no other lesions
Volumetric and Morphometry
Temporal Lobe Epilepsy
Malformation of Cortical Development

Focal Cortical Dysplasia with balloon cells
Focal Cortical Dysplasia (BSCD)
Seizure Control in Patients With Partial Epilepsy: The Role of Brain Abnormalities Detected by MRI

- N=26 Post-stroke
- N=57 Vascular malformation
- N=50 Tumor
- N=268 Normal MRI
- N=50 Closed Head trauma
- N=81 Cortical dysgenesis
- N=224 Isolated HS
- N=38 Dual pathology

% of seizure-free patients

HS = hippocampal sclerosis.

Frontal Lobe Epilepsy
Normal MRI

What tools do we have to improve Diagnosis?
High Resolution 8S-coils

- 32 y/o Female
- Epilepsy at age 13
- EEG: Multifocal
- Normal MRI
- Daughter with SBH

Grant et al 2004 MGH
Image Averaging
Focal Cortical dysplasia

1 SPGR series

4 SPGR series

Knowlton et al
Curvilinear Reformatting

Hemispheric contour (template) → progressively deeper slices → 3-D rendered surface
Voxel Based Morphometry
Identification of Abnormal Brain
MRI morphometry FreeSurfer

cerebral white matter
lateral ventricles
caudate nucleus
thalamus
putamen
pallidum
hippocampus

Pial surface
White matter surface
White matter surface
Cortical Thickness

- Distance between white and pial surfaces
- One value per vertex
Normative comparison of cortical thickness

NY123

Thickness

$z=9.4$

Compared to 12 normal controls
DTI
Automated Fiber Tracking
Track-density imaging (TDI): Thalamus

Highly localized seed ROIs

fMRI Language/ Memory Activation in TLE
Functional Connectivity in TLE

Pravata et al 2010
Functional Connectivity in GGE
Patient with FCD in the right parietal region

**Ictal EEG fMRI** showing increased BOLD in the FCD (seizure onset zone), and in the frontal lobe (seizure propagation) corresponding to seizure semiology.

**DTI** demonstrating significant reduction of WM fibers connecting the two areas of increased ictal BOLD (A) compared to the same areas in the contralateral (B) hemisphere.

Coan, Cendes et. al. unpublished
Functional Connectivity fMRI in Focal Epilepsy Predicts Surgery
Ictal SPECT correctly localized 12 of 15 patients (80%)

Seizure 14:213-220, 2005
## Ictal SPECT

**Epilepsy Surgical Outcome - Seizure Free**

|              | MSI  
|--------------|------
| n=27        |      |
| Sensitivity  | 54%  (31.3, 73.6) |
| Specificity  | 64%  (43.3, 82.7) |
| PPV          | 58%  (33.9, 79.8) |
| NPV          | 60%  (40.4, 77.1) |

|              | FDG-PET  
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<tr>
<td>n=27</td>
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<tr>
<td>Sensitivity</td>
<td>46%  (24.4, 62.3)</td>
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<tr>
<td>Specificity</td>
<td>79%  (58.4, 93.5)</td>
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<tr>
<td>PPV</td>
<td>67%  (35.3, 89.9)</td>
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<tr>
<td>NPV</td>
<td>61%  (45.4, 72.8)</td>
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<td>70%  (40.7, 90.8)</td>
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<tr>
<td>NPV</td>
<td>65%  (47.5, 77.0)</td>
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*Knowlton et al 2008*
Large Magellanic Cloud. Hubble Telescope August 2008
Abnormal Structural Changes in Epilepsy

Bernasconi et al 2011

Tosun et al 2011
7 T HRI TSE

0.1 mm Resolution   Grant et al 2004
Hippocampal Anatomy at 7 Tesla

14 min

Courtesy A. George, MD  NYU Imaging
11C-PBR PET Increased TSPO Binding Suggesting Inflammation in TLE/FLE

Tracy Buttler, MD, NYU CEC
Epilepsy and Depakote
Increased Cerebral Glutamine

Fetal MRI – Tensor Diffusion