PET in Epilepsy:
The Value of Multimodality Imaging

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No Disclosures
Evaluation of Drug Resistant Epilepsy

Clinical Exams
- Semiology
- Neuropsychologic Testing

Neurophysiology
- EEG
- Video EEG
- Intracranial EEG
- Dense Array EEG/ESI
- MEG/MSI

Structural Imaging
- Seizure Protocol
- MRI

Functional Imaging
- Perfusion SPECT
- F-18 FDG PET
- MR Spectroscopy
- BOLD fMRI
Zonal Approach

Zonal Approach

Epileptogenic Zone

Minimum amount of cortex that must be resected to achieve seizure freedom

Not defined by any imaging or physiologic testing – extent must be inferred

Zonal Approach

Seizure Onset Zone

Area of cortex that initiates clinical seizures

Ictal neurophysiologic testing, ictal SPECT

Zonal Approach

Epileptogenic Lesion

Macroscopic lesion that is causative of the epileptic seizures

Structural MRI

Zonal Approach

Functional Deficit Zone

Area of cortex that is functional abnormal during the interictal period

Neuropsychiatric testing, interictal EEG, interictal PET, interictal SPECT

Zonal Approach

Irritative Zone

Area of cortex that generates interictal spikes and sharp waves

Interictal neurophysiologic testing

Zonal Approach

Symptomatogenic Zone

Area of cortex which, when activated, produces the initial ictal signs and symptoms

Semiology

PET v SPECT

Ictal SPECT: 70-95%

Interictal SPECT: 20-30%

Interictal PET: 70-85%

Ictal SPECT: 40-70%

Interictal SPECT: 40-90%
How can F-18 FDG PET improve the interpretation of structural MR for pediatric epilepsy?
Case 1
14 yo M with 10 year hx of DRE

Semiology:
confusion, hypermotor behavior, rightward head turning, tonic posturing, fencing posture with right arm extended

EEG:
rare bifrontal interictal spiking with a 20ms right lead in, bifrontal seizures
14 yo M with 10 year hx of DRE

Semiology:
confusion, hypermotor behavior, rightward head turning, tonic posturing, fencing posture with right arm extended

EEG:
rare bifrontal interictal spiking with a 20ms right lead in, bifrontal seizures
14 yo M with 10 year hx of DRE

Semiology:
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EEG:
rare bifrontal interictal spiking with a 20ms right lead in, bifrontal seizures
Take Home Point

Focal hypometabolism on PET can direct attention to subtle findings of FCD or other malformations of cortical development on MR

Case 2
3 mo F with new onset epilepsy

Semiology:
generalized tonic-clonic seizures, left-sided tonic seizures, infantile spasms

EEG:
right hemihypsarrythmia
Follow up PET-CT

Semiology:
seizures resolved with initiation of antiepileptic medications

EEG:
right posterior slowing
Follow up PET-CT

Semiology:
seizures resolved with initiation of antiepileptic medications

EEG:
right posterior slowing
Original MR revisited

Semiology:
generalized tonic-clonic seizures, left-sided tonic seizures, infantile spasms

EEG:
right hemihypsarrythmia
The CT portion of the PET-CT examination can contain valuable clues to diagnosis that are unapparent on MR and should be routinely evaluated.
Case 3
2 yo M with 3 week hx of RUE
epilepsia partialis continua

Semiology:
RUE and right facial
epilepsia partialis
continua, myoclonic
seizures, R hemiparesis

EEG:
left centrotemporal
slowing, occasional
left centrotemporal spike
waves
2 yo M with 3 week hx of RUE epilepsia partialis continua

Semiology:
RUE and right facial epilepsia partialis continua, myoclonic seizures, R hemiparesis

EEG:
left centrotemporal slowing, occasional left centrotemporal spike waves
2 yo M with 3 week hx of RUE
epilepsia partialis continua

Semiology:
RUE and right facial
epilepsia partialis
continua, myoclonic
seizures, R hemiparesis

EEG:
left centrotemporal
slowing, occasional
left centrotemporal spike
waves
2 yo M with 3 week hx of RUE epilepsia partialis continua

Semiology:
RUE and right facial epilepsia partialis continua, myoclonic seizures, R hemiparesis

EEG:
left centrotemporal slowing, occasional left centrotemporal spike waves
2 yo M with 3 week hx of RUE epilepsia partialis continua

Semiology:
RUE and right facial epilepsia partialis continua, myoclonic seizures, R hemiparesis

EEG:
left centrotemporal slowing, occasional left centrotemporal spike waves
2 yo M with 3 week hx of RUE epilepsia partialis continua

Semiology:
RUE and right facial epilepsia partialis continua, myoclonic seizures, R hemiparesis

EEG:
left centrotemporal slowing, occasional left centrotemporal spike waves
2 yo M with 3 week hx of RUE
epilepsia partialis continua

Semiology:
RUE and right facial
epilepsia partialis
continua, myoclonic
seizures, R hemiparesis

EEG:
left centrotemporal
slowing, occasional
left centrotemporal spike
waves
Take Home Point

Bilateral mesial temporal hypermetabolism on PET in the absence of active seizing should prompt scrutiny of the MR and consideration of limbic encephalitis.

Case 4
8 yo M with 3 year hx of DRE

Semiology:
nonresponsiveness, left arm and leg rhythmic motor activity

EEG:
multifocal independent right-predominant interictal epileptiform discharges, right centroparietal seizure onset
8 yo M with 3 year hx of DRE

Semiology: nonresponsiveness, left arm and leg rhythmic motor activity

EEG: multifocal independent right-predominant interictal epileptiform discharges, right centroparietal seizure onset
8 yo M with 3 year hx of DRE

Semiology:
nonresponsiveness, left arm and leg rhythmic motor activity

EEG:
multifocal independent right-predominant interictal epileptiform discharges, right centroparietal seizure onset
8 yo M with 3 year hx of DRE

Semiology:
nonresponsiveness, left arm and leg rhythmic motor activity

EEG:
multifocal independent right-predominant interictal epileptiform discharges, right centroparietal seizure onset
8 yo M with 3 year hx of DRE

Semiology:
nonresponsiveness, left arm and leg rhythmic motor activity

EEG:
multifocal independent right-predominant interictal epileptiform discharges, right centroparietal seizure onset
8 yo M with 3 year hx of DRE

Semiology:
nonresponsiveness, left arm and leg rhythmic motor activity

EEG:
multifocal independent right-predominant interictal epileptiform discharges, right centroparietal seizure onset
Take Home Point

Wide-spread PET hypometabolism with admixed hypermetabolic foci is typical of Rasmussen encephalitis, which can be occult or nonspecific on MR

How can structural MR improve the interpretation of F-18 FDG PET for pediatric epilepsy?
Case 5
10 yo F with 9 year hx of DRE

Semiology: altered consciousness and nonspecific motor findings

EEG: rare centroparietal interictal spiking; right central and centroparietal ictal onset
10 yo F with 9 year hx of DRE

Semiology:
- altered consciousness
- and nonspecific motor findings

EEG:
- rare centroparietal interictal spiking;
- right central and centroparietal ictal onset
10 yo F with 9 year hx of DRE

Semiology:
- altered consciousness and nonspecific motor findings

EEG:
- rare centroparietal interictal spiking; right central and centroparietal ictal onset
Fusion of cortically-thresholded PET to MR images can aid in detection of subtle focal hypometabolism in depth-of-sulcus FCDs.

Case 6
16 yo F with 3 year hx of DRE

Semiology:
 altered consciousness, head and eye deviation to the right, orofacial automatisms

EEG:
 left frontal and temporal slowing, atypical left posterior temporal spike and sharp waves
16 yo F with 3 year hx of DRE

Semiology:
- altered consciousness,
- head and eye deviation to the right,
- orofacial automatisms

EEG:
- left frontal and temporal slowing,
- atypical left posterior temporal spike and sharp waves
16 yo F with 3 year hx of DRE

Semiology:
- altered consciousness
- head and eye deviation to the right
- orofacial automatisms

EEG:
- left frontal and temporal slowing
- atypical left posterior temporal spike and sharp waves
Periventricular nodular heterotopia is easily misinterpreted as normal cortex on PET, which can be avoided with MR correlation.
Case 7
2 yo M with recurrent DRE following partial R frontal lobe resection

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal clinical and subclinical seizures
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology:
unresponsiveness, cyanosis, head and eye deviation to the right

EEG:
right frontotemporal interictal discharges and slowing, right frontal ictal onset
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology:
- unresponsiveness,
- cyanosis, head and eye deviation to the right

EEG:
- right frontotemporal interictal discharges and slowing, right frontal ictal onset
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology:
unresponsiveness, cyanosis, head and eye deviation to the right

EEG:
right frontotemporal interictal discharges and slowing, right frontal ictal onset
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology:
unresponsiveness, cyanosis, head and eye deviation to the right

EEG:
right frontotemporal interictal discharges and slowing, right frontal ictal onset
14 mo M with 4 month hx of DRE and 3 episodes focal status epilepticus

Semiology:
unresponsiveness, cyanosis, head and eye deviation to the right

EEG:
right frontotemporal interictal discharges and slowing, right frontal ictal onset
Follow up MR after partial R frontal lobe resection

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Follow up MR after partial R frontal lobe resection

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
Follow up PET after partial R frontal lobe resection

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
Follow up PET after partial R frontal lobe resection

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
Follow up MR after partial R frontal lobe resection

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
Follow up MR after completion R frontal lobe resection

Semiology: unresponsiveness, cyanosis, head and eye deviation to the right

EEG: right frontotemporal interictal discharges and slowing, right frontal ictal onset
Take Home Point

The etiology of peri-resection PET hypometabolism can sometimes be elucidated by careful attention to pre- and post-resection MR.
Case 8
6 yo F with TS and 5 year hx of DRE

Semiology:
myoclonic jerking, eye fluttering, substantial speech and motor delay

EEG:
multifocal interictal spiking with prominent right temporal involvement
6 yo F with TS and 5 year hx of DRE

Semiology: myoclonic jerking, eye fluttering, substantial speech and motor delay

EEG: multifocal interictal spiking with prominent right temporal involvement
Take Home Point

Hypometabolism disproportionate to the size of the underlying tuber on MR is an indicator of an active lesion and can help guide surgical therapy.

Value of Multimodality Imaging

For MR interpretation

• Focal cortical dysplasia
• Dystrophic calcification
• Limbic encephalitis
• Rasmussen encephalitis

For PET interpretation

• Focal cortical dysplasia
• Periventricular nodular heterotopia
• Post surgical resection
• Tuberous sclerosis
Multimodality Imaging Fusion
Multimodality Imaging Fusion
Take Home Point

PET-CT and MR are **complimentary modalities** in the evaluation of pediatric DRE, and each has the potential to improve the **accuracy and quality** of interpretation of the other.
THANK YOU