PET IMAGING IN
NEUROBLASTOMA

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Neuroblastoma

• 3rd most common childhood malignancy
• 10% of all pediatric tumors
• 15% of cancer deaths in children age 1-4 years
Objectives

• Historical diagnostic evaluation
• Current practice
• PET evaluation
• Future
Neuroblastoma-MDP

- primary uptake 35-100%
- bony increased uptake
- symmetrical metaphyseal uptake
- photopenic lesions

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Symmetrical Metaphyseal Uptake

- neuroblastoma
- lymphoma
- leukemia

abnormal  normal

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Neuroblastoma - Radiotracers

- TC-99m MDP
- MIBG
- Tc-99m (V)DMSA
- Octreotide
- Monoclonal antibody
Neuroblastoma-MIBG

- diagnosis
- staging
- metastatic work-up
- response assessment
- treatment

normal I-123 MIBG

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Neuroblastoma

- MIBG to assess extent of disease including primary tumor, and bone disease
- MDP bone scan if MIBG negative or unavailable
- x-ray positive lesions
- PET if MDP and MIBG are negative
Neuroblastoma

• staging must distinguish between stage IV and IV-s
• 5 year old boy who presents with leg pain
Dx- stage IV Neuroblastoma

I-123 MIBG
Stage IV-S Neuroblastoma
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Neuroblastoma

- MIBG-marrow disease > cortical bony disease
- MDP-cortical > marrow disease
Neuroblastoma-MIBG screening

- MEN
- opsoclonus-myoclonus (OMS)
- Up to 50% have NB
- 1-3% NB present with OMS
- normal adrenal activity in 50% I-123

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Somatostatin-Receptor Imaging

- Somatostatin receptors present on neuroblastoma cells
- Indium-III label; octreoscan
- Normal biodistribution: liver, spleen, kidneys, gut
Radiolabeled Monoclonal Antibodies

- I-131 or I-123 radiolabel
- 3F8: murine IgG antibody specific for ganglioside G\textsubscript{D2}
- G\textsubscript{D2} is absent in normal tissues but present in high concentration in neuroblastomas

- tracer localization in both primary tumors and metastases
- highly sensitive
- highly specific
- potential targeted radiotherapeutic agent

Image courtesy of Dr. Sam Yeh
MDP

I-123 MIBG

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FALSE NEGATIVE MIBG

- Specificity MIBG > 96%
- ? Better outcome ? Worse outcome
- Complementary imaging
- I-131 vs I-123
- Ganglioneuroma vs neuroblastoma
- Cortical vs marrow disease

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PET - FDG

• uptake in variety of tumors
• uptake related to enhanced glycolytic metabolism of tumor cells as compared to normal cells
NEUROBLASTOMA-FDG

Images courtesy of Dr. Barry Shulkin

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Neuroblastoma and FDG

- Most concentrate FDG
- Rapid uptake within 20-30 minutes post injection
- Uptake higher pre treatment than post treatment
SUV in Pediatric Patients

- Adult dependence on body weight
- Pediatric body-surface based SUV more uniform than if calculated on body weight alone
- ~independent of body parameters and age
- Neuroblastoma SUV in study 25.9±15.4

Decline-corrected activity (kBq) / tissue volume (ml)

Injected FDG dose (kBq) / body surface area (m²)
Advantages:

- does not depend on Type 1 catecholamine uptake mechanism of MIBG
- useful in those 10% of neuroblastomas that are not MIBG avid
- liver lesions better visualized where obscured by MIBG
PET - FDG

Disadvantages:

- lower tumor to non-tumor uptake ratios when compared to MIBG
- less reliable than MIBG in those patients undergoing or post-chemotherapy
- normal uptake in kidneys, gut, thymus may confuse interpretation
- accumulation in normal bone marrow precludes assessment for disease
- poor vis cranial vault
- nonspecific uptake in inflammation
# Neuroblastoma and FDG

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**Sens 92% Spec 92%**

Kushner, Clin Oncol 2001; 19: 3397-3405
Shulkin, Radiology. 1996; Jun; 199(3): 743-50

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Ca++ in tumor

Images courtesy of Dr. B. Shulkin

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Intense bone uptake

Images courtesy of Dr. B. Shulkin

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Tonsil uptake 27 mo old

Images courtesy of Dr. B. Shulkin

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Intense brown fat and tumor

Images courtesy of Dr. B. Shulkin

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PET in Neuroblastoma

- Memorial Sloan Kettering experience
- PET was = or superior to MIBG in soft tissue and extracranial structures
- Recommend PET and marrow aspiration for monitoring patients after resection of primary tumor

11-C-hydroxyephedrine (HED) in Neuroblastoma

- PET probe for visualization of sympathetic nervous system
- rapid uptake and high retention
- good visualization within 5 min of injection
- lesion distribution similar to MIBG
- high hepatic and renal uptake HED which declines rapidly
- limited comparison to FDG but uptake HED superior

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PET Radiotracers in Neuroblastoma

- 18-FDG
- C-11 hydroxyephedrine
- C-11 epinephrine
- C-11 5-hydroxytryptophan
- 18- F- (fluoroalkyl)benzylguanidines
- I-124 MIBG
MicroPet of Reporter Genes


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Biologic Poor
Prognostic Factors

- N-myc amplification
- DNA di or tetra ploidy
- 1p deletion short arm chromosome one
- Gain of 17q region
- high MRP expression
Objectives

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• Current practice
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• Future