

# Pediatric Nuclear Medicine

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# Most Common Studies

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- Bone Scan
- VCUG
- Renal Scan
- Milk Scan - G E Reflux Study
- Liver - Spleen/ Lung Scan/ Heart/ Gallium
- Thyroid/ Brain/ Meckel's/ Testicular

# Special Considerations

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- Different Pathologies
- 10X radiation absorption doses in infants
- Different behavior and emotional needs
- “People Intensive” procedures
- More time and patience
- Special examination/ waiting room
- Informing patients/ parents

# Special Considerations

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- Twice as long => Expensive
- Sedation and immobilization
- Injection technique
- Instrumentation
- Magnification – Pinhole Collimator: hips, kidneys, Myocardium, Thyroid (high spatial resolution)
  - Converging Collimator: Dynamic studies (high sensitivity)

# Bone Scan

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- Radio-pharmaceuticals – Tc99m MDP/ TC99m, EHDP/ Ga-67/ Sulfur Colloid-Tc99m
- Biodistribution: Active Growth Centers
- Procedure:
- Indications: Early Dx of osteo, Evaluation of bone pain, Dx of stress reaction and fracture, Dx of avascular necrosis and revascularization, Dx of localization and evaluation of the extent of primary and metastatic bone tumors, Child abuse

# Bone Scan

- Increased uptake: primary/ secondary tumors, inflammatory disorders, fractures, metabolic diseases, arthritides
- Decreased uptake: bone cysts, avascular necrosis, infarcts, radiotherapy fields, osteo-necrosis, histiocytosis
- Osteomyelitis: Hematogenous / metaphysis / staph. Aureus, Atypical presentation / 3 phase scan, Negative scan does not r/o osteo → repeat/ Ga 67
- Osteosarcoma: extent of primary lesion, dx of skeletal and soft tissue metastasis

# Bone Scan

- Ewing's Sarcoma – 1st 2 decades, males, pelvis > ribs > femurs > spine > tibia > fibula, midshaft, bone metastasis
- Osteoid Osteoma – young adults, benign osteoblastic lesions, intense focal uptake surrounded by area of diffusely high uptake
- Neuroblastoma – high uptake in primary lesion and bone metastasis
- Assessment of mandibular growth and asymmetry

# Bone Scan in Sickle Cell Disease

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- Sulfur Colloid Scan: Dx of bone marrow infarction
- High uptake of MDP – reaction to infarction
- Splenic uptake – infarction
- High periphery bone marrow activity – anemia
- large intense kidney on bone scan – iron overload

# Renal Scan

- Radiopharmaceuticals: DTPA – glomerular filtration, DMSA – prox. convoluted tubules, Glucoheptonate – glomerular filtration and tubular transport, OIH = PAH – 90% 1st pass extraction
- Procedure: Calculation of GFR and ERFP (blood sampling vs imaging)
- Indications: Evaluate function / size / location of kidneys, Evaluate flank masses, Hydronephrosis, Pyelonephritis, Transplant, Trauma / infarct / HTN

# V.C.U.G

- Reflux -> recurrent infection -> pyelonephritic scars -> HTN -> chr. renal failure
- Reflux: Female, 35%, resolves with age (70%)
- Radiographic vs. radionuclide VCUG: Males vs. females, Radiation dose, Sensitivity, Quantitation
- Indications – screening, f/u, siblings
- Tc 99M as sodium pertechnetate
- 1 mCi in 500 cc sterile saline/ catheterization
- low (I – III) vs. high grade reflux (IV – V)

# Testicular Scan

- Indications: Early dx of torsion (bell clapper anomaly), differentiation between torsion and epididymitis
- Tc99M pertechnetate (flow and tissue phase)
- Acute torsion (<24hour) -> decreased perfusion/ 'cold' area
- Missed torsion (>/= 24 hour) ->  $\approx$  angiogram / halo
- Epididymo-orchitis -> high flow / hot

# Liver – Spleen Scan

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- Evaluation of masses, infectious processes, trauma, congenital malformations, infarcts, asplenia, accessory spleen, diffuse parenchymal disease
- Tc99m sulfur colloid (0.01 – 1.0 microns)
- Phagocytosis by kupffer cells of RE system
- Liver: 80 – 90%, Spleen 5 – 10%, Rest: BM
- Tc99m heat denatured RBC's

# Hepato-biliary (HIDA) Scan

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- Indications: Differentiation between biliary atresia and Neonatal Hepatitis, RUQ pain, RUQ mass, choledochal cyst, F/u after surgical interventions
- Tc99m labelled IDA (iminodiacetic acid) derivatives (disofenin, mebrofenin), +3 state, stannous ion kit
- Procedure:

# Gastro-Esophageal Reflux (Milk Scan)

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- GE Reflux: 60% resolve by 18 months, 30% have symptoms until 4 years
- No sedation / prolonged observation / high sensitivity / low radiation exposure
- Tc99m sulfur colloid in milk
- Procedure: burped and placed supine, anterior and posterior imaging of abdomen / thorax / mouth
- GER / aspiration/ Gastric Emptying

# Meckel's Scan

- Meckel's diverticulum: 1 to 3%, 3 times more common in males, incomplete closure of embryonic vitelline duct / omphalomesenteric duct
- Antimesenteric side of ileum, 90 cm proximal to ileocacal valve, 1 – 56 cm in length, 1 – 50 mm in diameter
- Usually contains ileal mucosa (gastric in 50%), most common cause of LGI bleed in infants
- Scan identifies ectopic gastric mucosa /surface cells/secreted, Pentagastrin /cimetidine /glucagon
- Angiogram / delayed views / lateral views
- RLQ focus / increases in intensity / anterior

# Thyroid Scan

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- Indications – evaluation of nodules / neck masses, detection of ectopic thyroid / dx of hyper and hypothyroidism / treatment of thyroid cancer
- I 123 / Tc99m as NaTc-99mO<sub>4</sub> / I 131
- Procedure: pinhole collimator
- Tc99m trapped and not organified
- TSH stimulation / T3 Suppression test

# Brain Scan

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- Indications: ICSOL / trauma / inflammatory conditions / seizures / stroke / vascular abnormalities / brain death
- BBB imaging – Tc99m pertechnetate / Tc99m DTPA / glucoheptonate
- Angiography / delayed planar images: 3 phases – (Trident) / capillary / venous arterial
- Cerebral perfusion agents: Tc 99m ECD / Tc99m HMPAO

# Cisternogram

- Observe mixing and absorption of CSF
- In111 DTPA / Tc99m DTPA -> subarchoid space
- Series of static images at 2 – 6 – 24 hours
- Determination of leak / hydrocephalus
- 6 hour -> sylvian fissure, 24 hour ->convexity
- Communicating (extra ventricular obstructive) H -> circulates into the ventricular system and does not appear in the cerebral fissure and on the convexity
- Assessing patency of CSF shunts/ CSF leaks

# Dacryoscintigraphy

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- MC anomaly: congenital obstruction of naso lacrimal duct
- 100 microCi in 10 ml / lower temporal marginal tear strip
- Dynamic acquisition – 20 min
- SAC – 1 minute, duct – 2 to 3 minutes
- Sac max – 1 to 15 minutes
- Blinking / deep nasal breathing

# Nuclear Cardiology

## First pass radionuclide angiography

- Indications: detection, localisation / quantitation of cardiovascular shunts, Image normal and abnormal circulatory patterns within heart, lungs and great vessels
- Tc99m pertechnetate / Tc99m RBC's (cardiac output)
- Dilution principle, Rapid compact injection (ext. jugular V)
- L -> R shunt – persistently high level of activity in lungs and Right side of heart due to early recirculation
- R -> L shunt – ROI over left ventricle, Tc99m MAA, (Comparing the whole body to lung activity)

# Nuclear Cardiology

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## Gated Blood Pool Angiography (MUGA)

- Assess global and regional ventricular function / quantitate, valvular regurgitation
- Tc99m RBCs / EKG gating

## Myocardial Perfusion Scintigraphy (SPECT)

- Evaluation of anomalous coronary artery (from pulmonary artery), Evaluation of Right ventricular hypertrophy and hypertension, Cardiomyopathy / tumor / transplant

# Lung Scan – V/Q

- Indications: Assessment of regional lung functions, Pulmonary artery agenesis/ embolism/ pulmonary valve stenosis/ sequestration/ hemoptysis / Swyer James syndrome, Bronchial disorders / allergic and metabolic disorders / infectious diseases
- Tc99m MAA (less number of particles for infants) Xe133 / Kr81m / Tc99m DTPA
- Right – 55%, Left – 45% of total lung volume
- Cystic Fibrosis – delayed wash in and wash out, and systemic penetration of Xe133, more severe in upper lung zones
- 10% of embolism occur in pediatric population