RADIONUCLIDE IMAGING IN UROLOGY

KHORTZE WEI
• Utilizes radiopharmaceutical to assess target organ

• Radioactivity is detected and quantify by gamma camera

• Poor spatial resolution demonstrating physiology rather than anatomy
IDEAL RADIOPHARMACEUTICAL

• 1. Label bound to pharmaceutical in vivo
• 2. Pharmaceutical concentrate only in target organ
• 3. Non-toxic and no interference with physiological process
• 4. Should emit only gamma rays (100–300keV energy)
• 5. Suitable half-life (prepare and complete test)
• 6. Cheap and readily available
• Renal scintigraphy - function, drainage, infection

• $^{99m}$Tc-DTPA (diethylene triamine pentaacetic acid), DMSA (dimercaptosuccinic acid) and MAG 3 (mercaptoacetyl triglycine)

• Oncology imaging - diagnosis, staging

• PET, MIBG, bone scan
• Properties of Technetium-99m

• Gamma rays only

• 140 keV

• Half life 6 hour

• Readily available from a generator
DMSA

- High affinity for the renal cortex

- Static parenchymal imaging

- Accurate assessment of relative renal function (scar detection: sensitivity - 96% and specificity - 98%)

- Minimal GFR clearance

- Extracted by the cells of the proximal convoluted tubules allowing slow concentration of radioactivity in the renal cortex

- After 3 hours, about 50% of the injected tracer is concentrated in the kidneys, remaining there for up to 24 hours.
INTERPRETATION

• Normal kidneys: homogenous parenchymal distribution with visible demarcation between the cortex and medulla

• Preservation of cortical thickness - acute changes, cortical thinning - chronic damage

• Scars or other deformities - areas of decreased or absent activity within the parenchyma

• Diagnosis of acute pyelonephritis & follow up chronic pyelonephritis
MAG3

• Clearance is predominantly by tubular secretion (minimal glomerular filtration)

• Preferred in renal failure/urinary obstruction

• MAG3 excretion is 70% at 30 minutes, and by 3 hours 90%

• Assessment of split function and obstruction
DIURESIS RENOGRAPHY

• Popularized by O’Rielly

• Maximal diuretic response within 5–10 minutes

• Rationale: increase the sensitivity of the dynamic renal study by increasing urine flow rates to stress the system, such that minor degrees of obstruction are unmarked

• Various protocol: F+20, F-15, F+0
O’Reilly’s Curve

- **Type I**—normal response
- **Type II**—obstructive response (high-pressure system)
  - no response to frusemide, inconclusive if GFR < 15mL/min
- **Type IIIa**—dilated but not obstructed (low pressure/ hypotonic system)
  - stasis rather than obstruction, prompt elimination following frusemide injection
- **Type IIIb**—equivocal response
  - languid response to diuretic, repeat study with F-15
- **Type IV**—delayed compensation (Homsy’s sign)
  - “double peak” response to diuretic, F-15 diuresis often reveal obstructed pattern
FACTORS AFFECTING DIURESIS RENOCGRAM CURVE

• Hydration

• Renal function

• Renal disease (ATN)

• Collecting system volume

• Collecting system compliance

• Bladder effects

• Ureteric dilatation or obstruction

• Tandem obstruction
DTPA

- cleared solely by glomerular filtration
- kidney uptake is low and blood background remains high
- makes background subtraction more difficult in children or pt with poor kidney function
BONE SCAN

• 95% sensitivity for detecting skeletal metastatic disease

• $^{99m}$Tc-methylene diphosphonate, MDP (medronate)

• Reflects osteoblastic activity

• Often positive before plain X-ray changes are apparent, 6 months

• Diagnosing, monitoring progress and response to treatment
FACTORS AFFECTING BONE SCAN

• Fractures, infections, necrosis, Paget’s disease, degenerative changes and primary bone tumors

• Residual tracer in bladder might obscure bony pelvis (consider catheterising the patient or void before imaging)

• Movement artifacts during imaging

• Extravasation or spillage of tracer which may confuse analysis (remove/change clothing if required)
• Skeletal spread uncommon (<2%) in PSA <2; present in >90% PSA >50

• Low risk Ca Prostate without bone pain does not justify a bone scan

• Advances widespread metastasis may demonstrate a “superscan”

• A symmetrical increased uptake throughout the skeleton

• Minimal soft tissue activity

• Absent or dim renal outlining

• Might be mistaken for normal scan