



UNC

SCHOOL OF MEDICINE

Radiology

# Nuclear Medicine for Newbies

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Division of Nuclear Medicine

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# Ed Module Outline

- Commonly-performed NM examinations at UNC
- Radiopharmaceutical, Technique, Indications with normal exams illustrated
- Need to Knows highlighted
- Case-based Q&A of six 'Aunt Minnies'

# What's a radiopharmaceutical?

- A **radionuclide** (which is radioactive and emits something we can detect, usually gamma rays) is bound to a **pharmaceutical** (which gives the physiologic function) to make a **radiopharmaceutical** or **radiotracer**
  - For example, we attach technetium-99m to DTPA, which is filtered by the kidney, to calculate glomerular filtration rate.
  - Or we can attach it to MDP, which is taken up by the bone, to do a bone scan.

UNC Hospitals Division of Nuclear Medicine

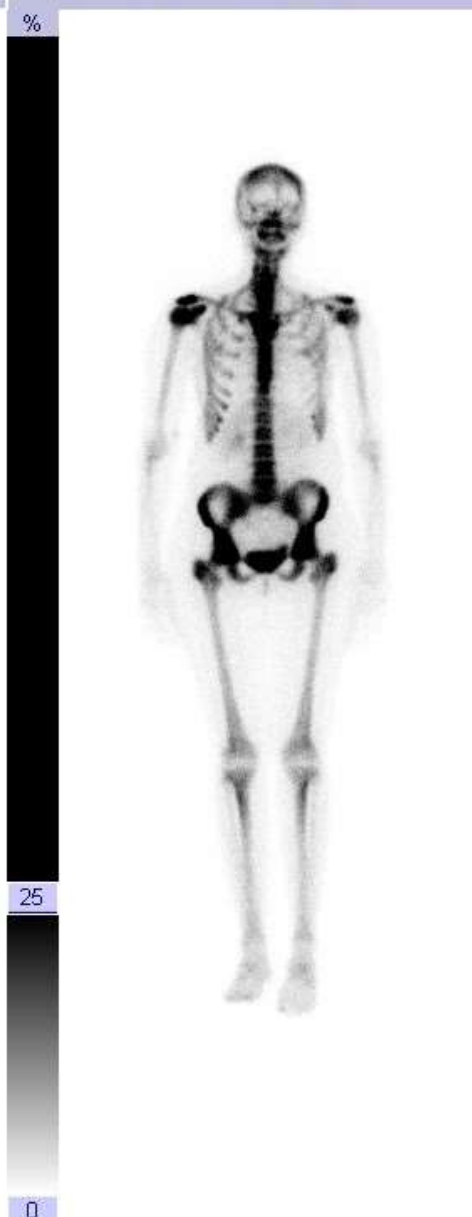
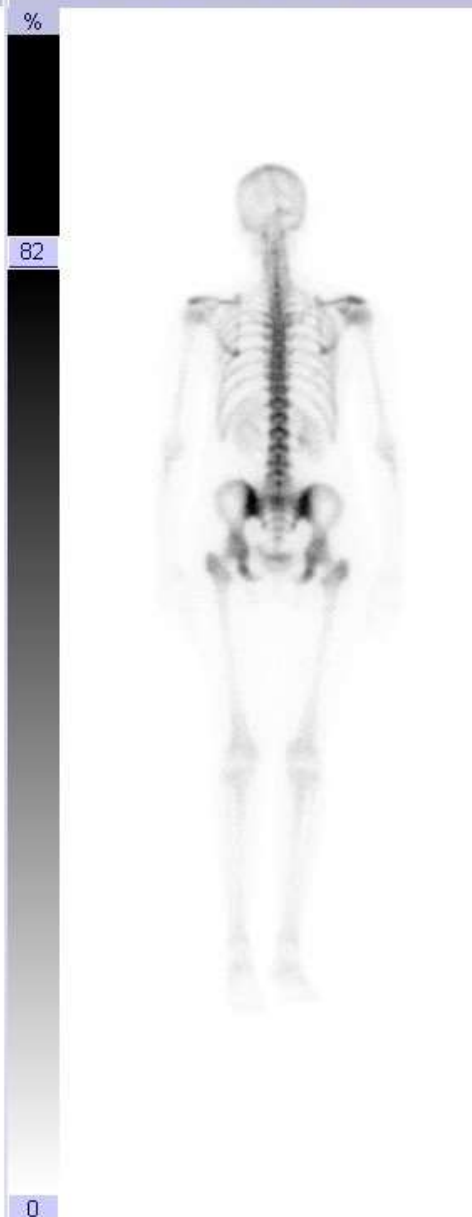
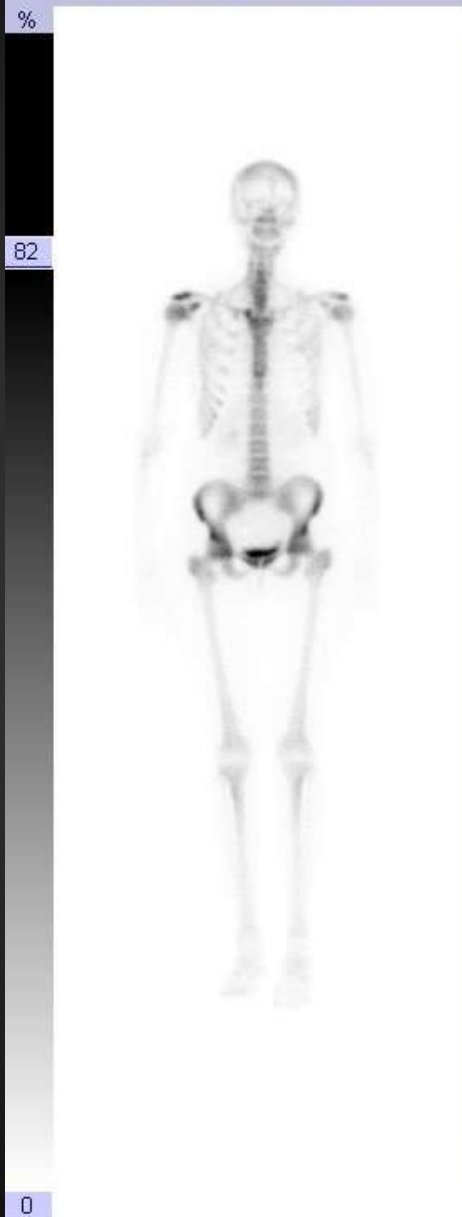
Rt Superior Lt Lt Superior Rt Rt Superior Lt Lt Superior Rt

3 Hr WB Bone Scan 3/1/2016

3 Hr WB Bone Scan 3/1/2016

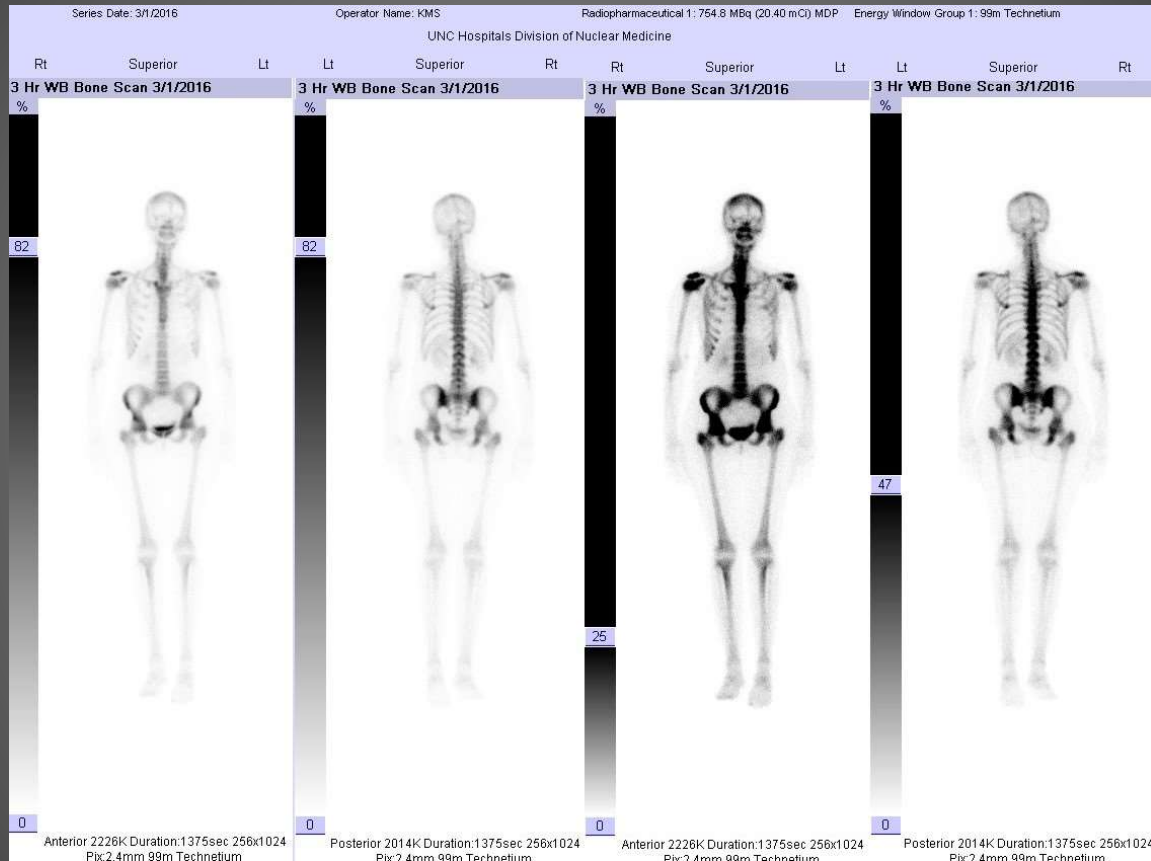
3 Hr WB Bone Scan 3/1/2016

3 Hr WB Bone Scan 3/1/2016



# Normal Whole Body Bone Scan

*Clinical Indication: 44yoF new diagnosis breast cancer*



- Search Pattern Tips: Look for focal uptake outside the joints, especially in the axial and proximal appendicular skeleton
- Critical Organ: Renal

# Whole Body Bone Scan

- *Radiopharmaceutical:*  $^{99}\text{Tc}$ Technetium Methylene Diphosphonate (MDP) IV
- *Technique:* planar
- *Indications:* bone neoplasm to include primary and metastatic disease, trauma
- *Need to Knows:* which tumors do we get bone scans for? (breast, prostate, most others use PET scan)
  - *Breast cancer often sends solitary metastases to the sternum, whereas prostate cancer metastases often start in the spine*
  - *Any history of trauma? Inflammatory or degenerative arthritis?*

Series Description: VENT

Radiopharmaceutical 1: 407.0 MBq (11.00 mCi)

Lt Posterior Superior Rt



Lt Posterior Superior Rt



Ph:1-2 Fr:2-13 191K 5sec Duration:85sec 128x128 Pix:3.9mm 133-Xenon

Posterior 500K Duration:142sec 256x256 Pix:1.9mm 99m Technetium

(B:0%,T:88%)

(R:0%,T:120%)

Rt Anterior Superior Lt



Rt Anterior Superior Lt

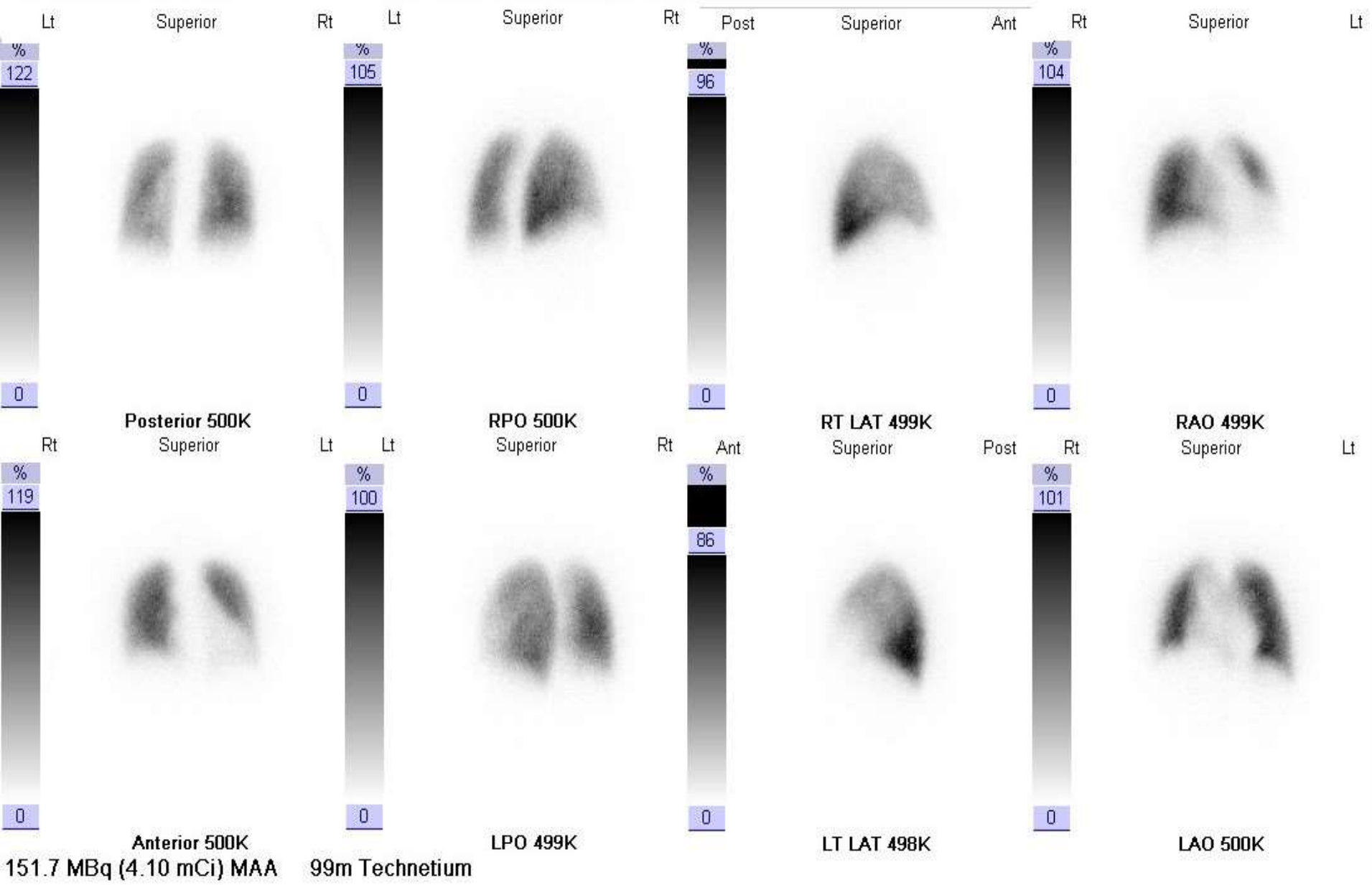


Ph:1-2 Fr:2-13 162K 5sec Duration:85sec 128x128 Pix:3.9mm 133-Xenon

Anterior 500K Duration:142sec 256x256 Pix:1.9mm 99m Technetium

Series Description: Perfusion

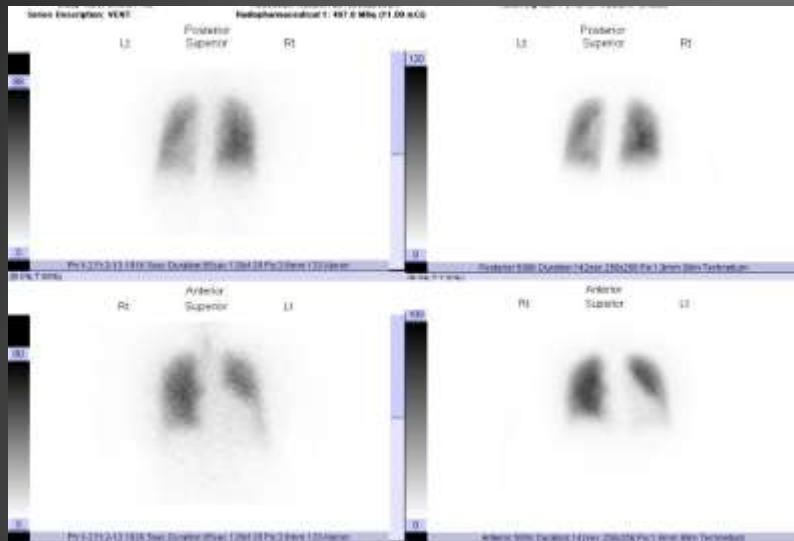
Radiopharmaceutical 1: 151.7 MBq (4.10 mCi) MAA



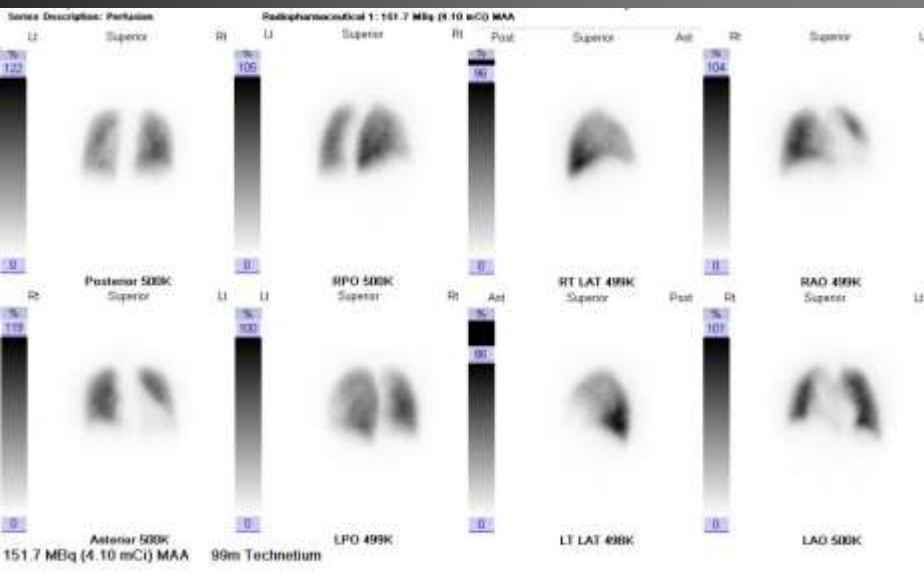


# Normal V/Q Scan

*Clinical Indication: 46yoF acute shortness of breath*



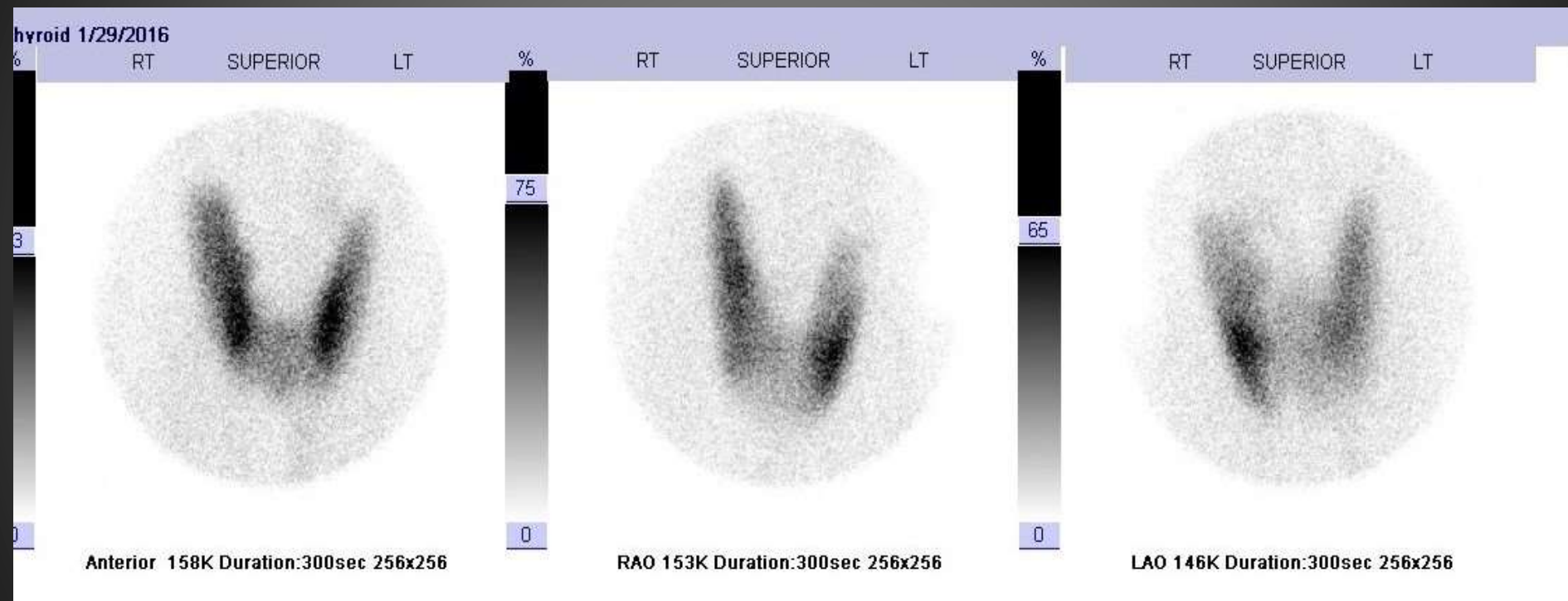
- Dual planar exam, Ventilation (“V”) followed by Perfusion (“Q”)
- Mismatch of ventilated and perfused lung segments in PE ie segments are ventilated but not perfused due to pulmonary arterial emboli
- Search Pattern Tips:
  - Look for wedge-shaped peripheral defects
  - Make sure they are not also absent on ventilation images



# Ventilation Perfusion Scan

- *Radiopharmaceutical:*  $^{133}\text{Xenon}$  inhalation gas followed by  $^{99}\text{Tc}$  Technetium Macro-Aggregated Albumin (MAA) IV
- *Technique:* planar
- *Indications:* acute or chronic pulmonary embolism and pulmonary hypertension
- *Need to Knows:*
  - Should be done with a chest X-ray
    - Other lung illnesses such as COPD, pneumonia, or a pleural effusion will produce matched defects
  - Often done when there is bad renal function, a contrast allergy, or there is a strong desire to decrease radiation dose.

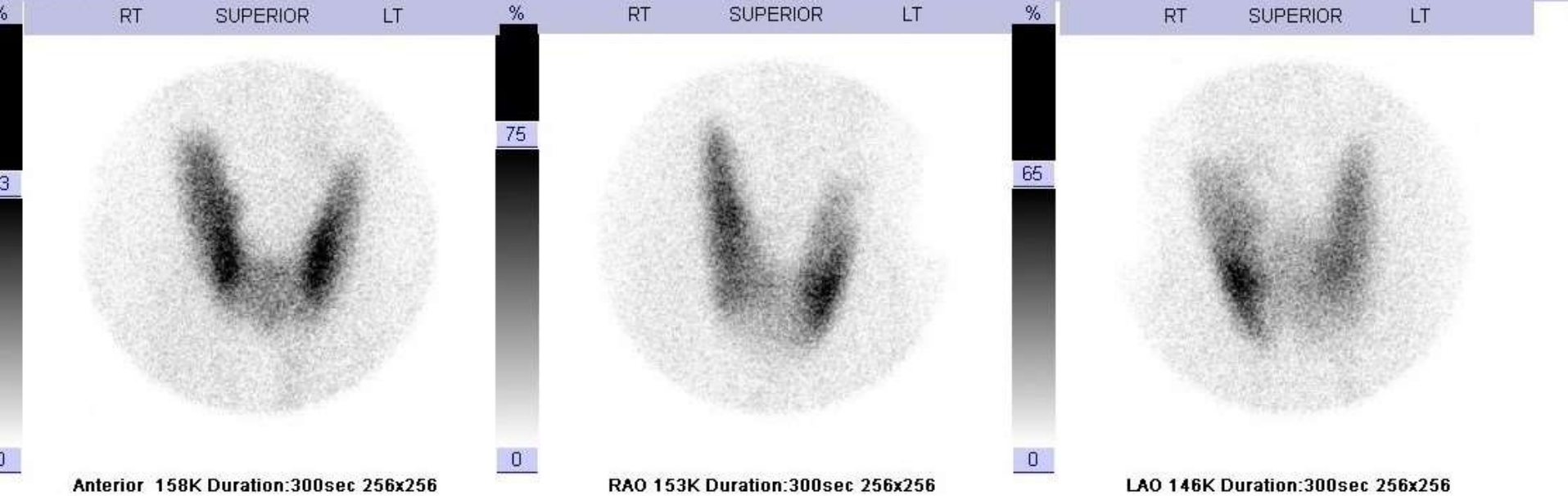
$^{131}\text{I}$  24 hour Thyroid uptake = 27.4% (Normal range = 15-35% at 24 hrs)



# Normal Thyroid Uptake and Scan

*Clinical Indication: 20yoF with subclinical hyperthyroidism*

Thyroid 1/29/2016



$^{131}\text{I}$  24 hour Thyroid uptake = 27.4%. (Normal range = 15-35% at 24 hrs)

- Search Pattern Tips: Lumpy or smooth? Background? Salivary glands?
- Critical Organ: Thyroid

# Thyroid Uptake and Scan

- *Radiopharmaceutical:*  $^{131}\text{I}$  Iodine Sodium Iodide PO (to calculate uptake) and  $^{99\text{m}}\text{Tc}$  Technetium pertechnetate IV (to get pictures)
- *Technique:* planar
- *Indications:* goiter (in situ, substernal), benign thyroid nodules, multinodular gland, and hyperthyroidism (Graves disease, thyroiditis, and toxic nodules)
  - Graves will give you a smooth gland, multinodular goiter a multinodular one; both (particularly Graves) will suppress background and salivary gland activity
  - A hot nodule is a toxic adenoma; a cold one may be malignant
  - If you don't see anything and the uptake is low, subacute thyroiditis (or bad preparation) is a possibility
- *Quantitative techniques:* uptake probe (24-hour radioiodine uptake)
- *Need to Knows:* Did they abstain from antithyroid medications or thyroid hormone beforehand? (3-5 days for MTZ/PTU, 2 weeks for Cytomel, 6 for Synthroid) Recent contrast-enhanced CT scan? (6 weeks)

Rt Superior Lt Lt Superior Rt Rt Superior Lt Lt Superior Rt

%

%

%

%

68

87

50

68

0

0

0

0

Anterior 84K Counts Duration:1441sec  
256x1024 Pix:2.4mm 131-Iodine

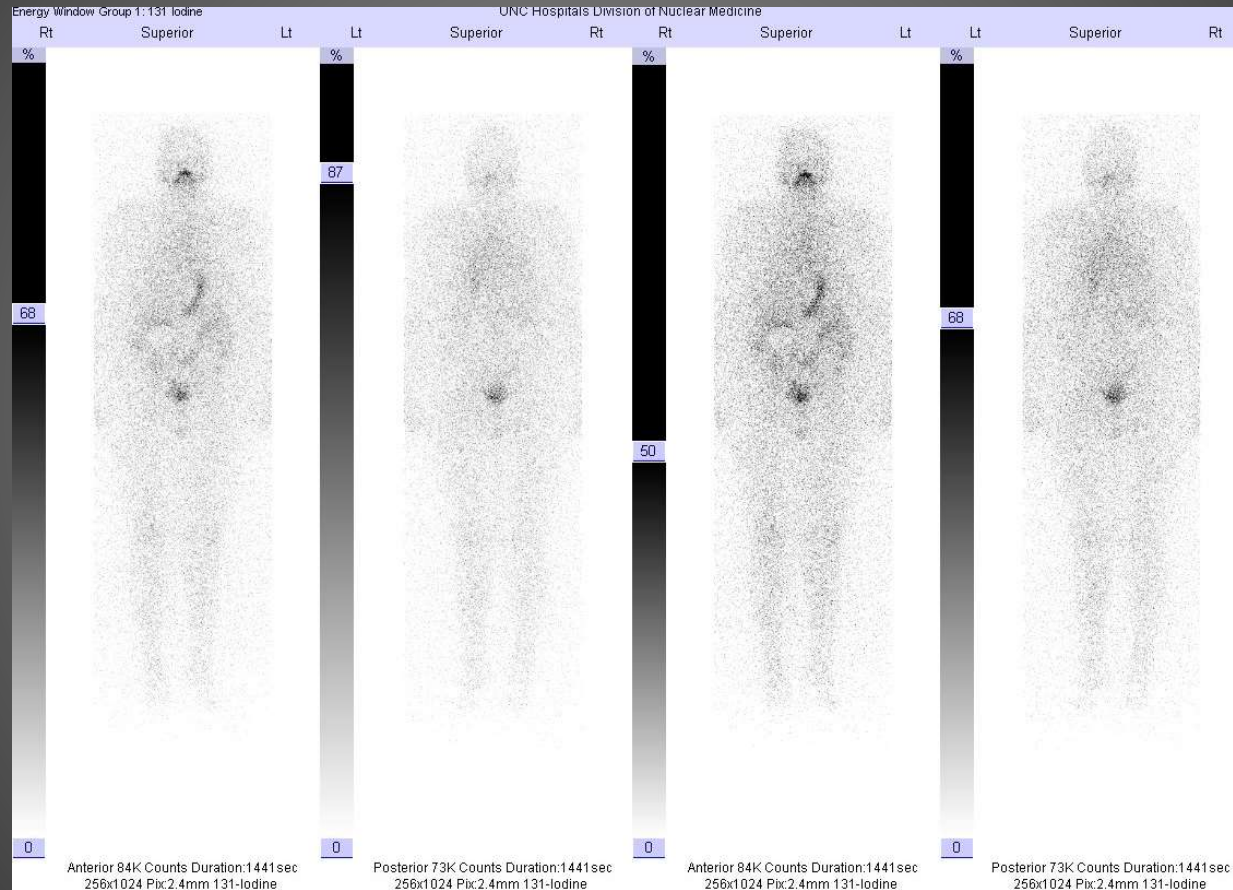
Posterior 73K Counts Duration:1441sec  
256x1024 Pix:2.4mm 131-Iodine

Anterior 84K Counts Duration:1441sec  
256x1024 Pix:2.4mm 131-Iodine

Posterior 73K Counts Duration:1441sec  
256x1024 Pix:2.4mm 131-Iodine

# Normal Whole Body Thyroid Scan

*Clinical Indication: 37yoF status post Rx follicular thyroid CA*



- Search Pattern Tips: Uptake outside usual organs (nose, mouth, thyroid bed, liver, bladder)? Particularly lung or bone?
- Critical Organ: Bladder

# Whole Body Thyroid Scan

- *Radiopharmaceutical:*  $^{131}\text{I}$ odine or  $^{123}\text{I}$ odine Sodium Iodide PO (or IV)
- *Technique:* planar, SPECT and/or SPECT-CT
- *Indications:* post thyroidectomy or thyroid ablation, thyroid bed remnant, and staging locoregional disease/distant metastases for papillary and follicular and medullary cancers
- *Need to Knows:*
  - Should be off thyroid hormone until TSH is above 30 (usu. 6 weeks for Synthroid, 2 weeks for Cytomel), or be given Thyrogen (recombinant TSH) for two days before test
  - Negative pregnancy test



# Normal PET Scan

*Clinical Indication: 47yoF history of treated recurrent breast cancer*

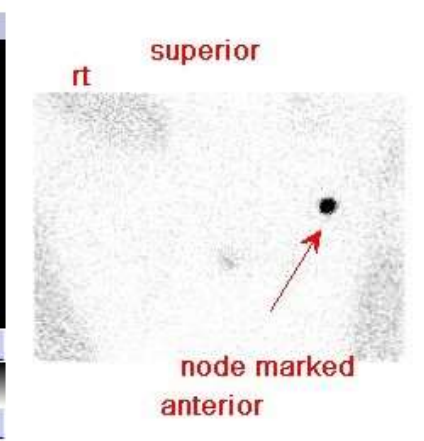
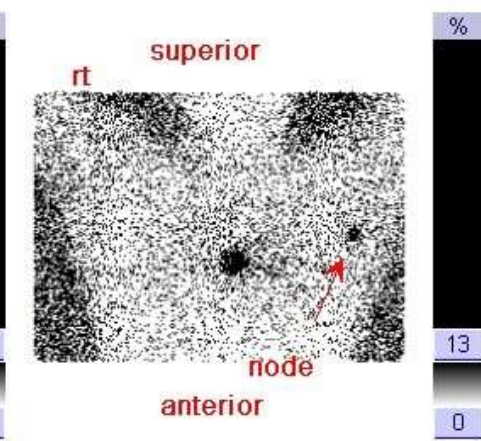
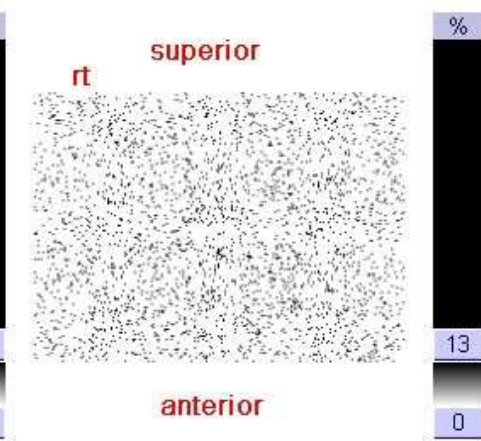
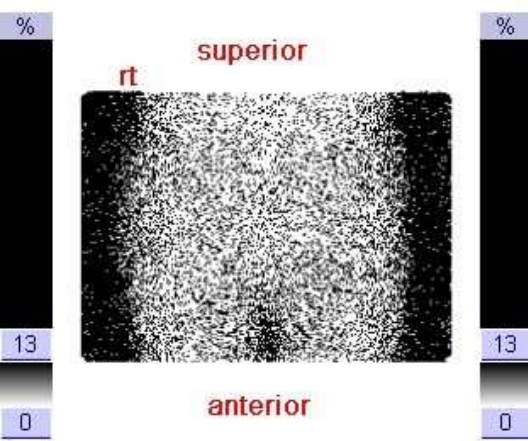
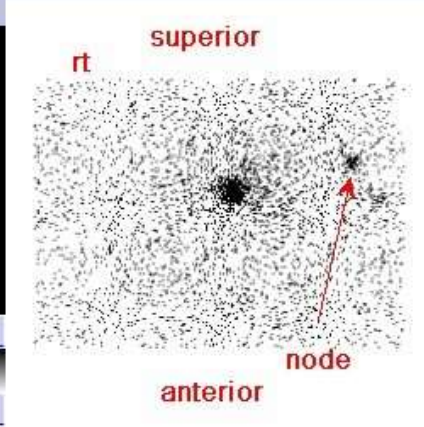
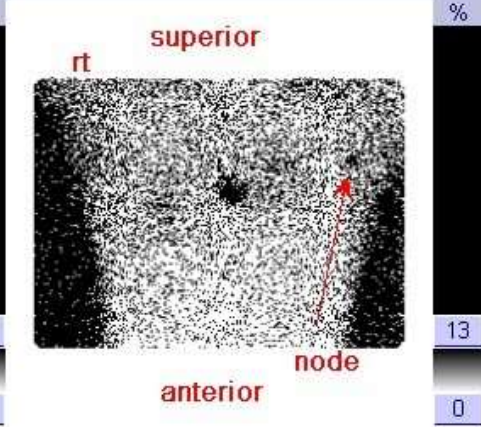
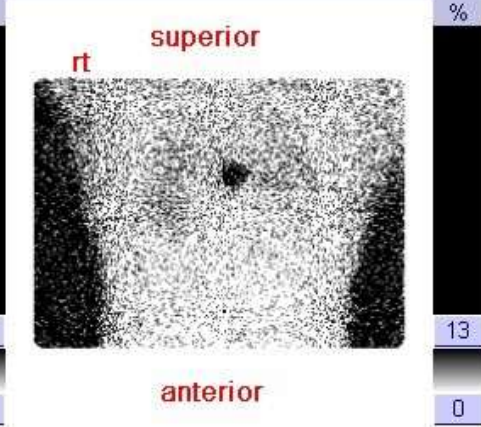
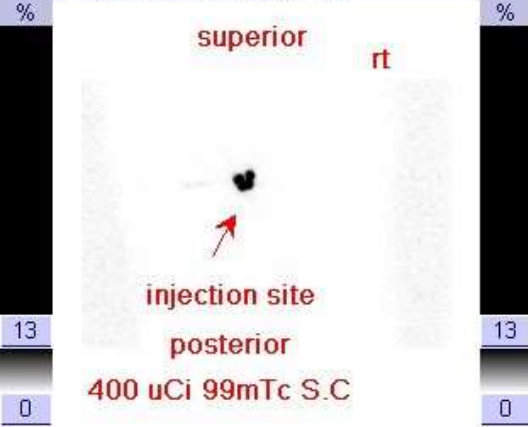


- Search Pattern Tips:
  - Look for hot spots in **lymph nodes, lung, liver, and bone**
    - You can't see brain mets, the brain is too hot
  - **Adrenals** for lung cancer
  - **Peritoneum** for GI and GYN tumors
  - Is the **spleen** hot in a lymphoma?
  - In a melanoma, look everywhere
  - Since there's a CT, go back and check for lung nodules
- Preparation
  - Patient should be NPO for 4 hours and have received no insulin for 6; no exercise for 24
  - With diabetic patients we do the best we can since we don't want patients to be hypoglycemic; however, insulin does drive glucose into muscle
- Critical Organ: Bladder

# PET Scan

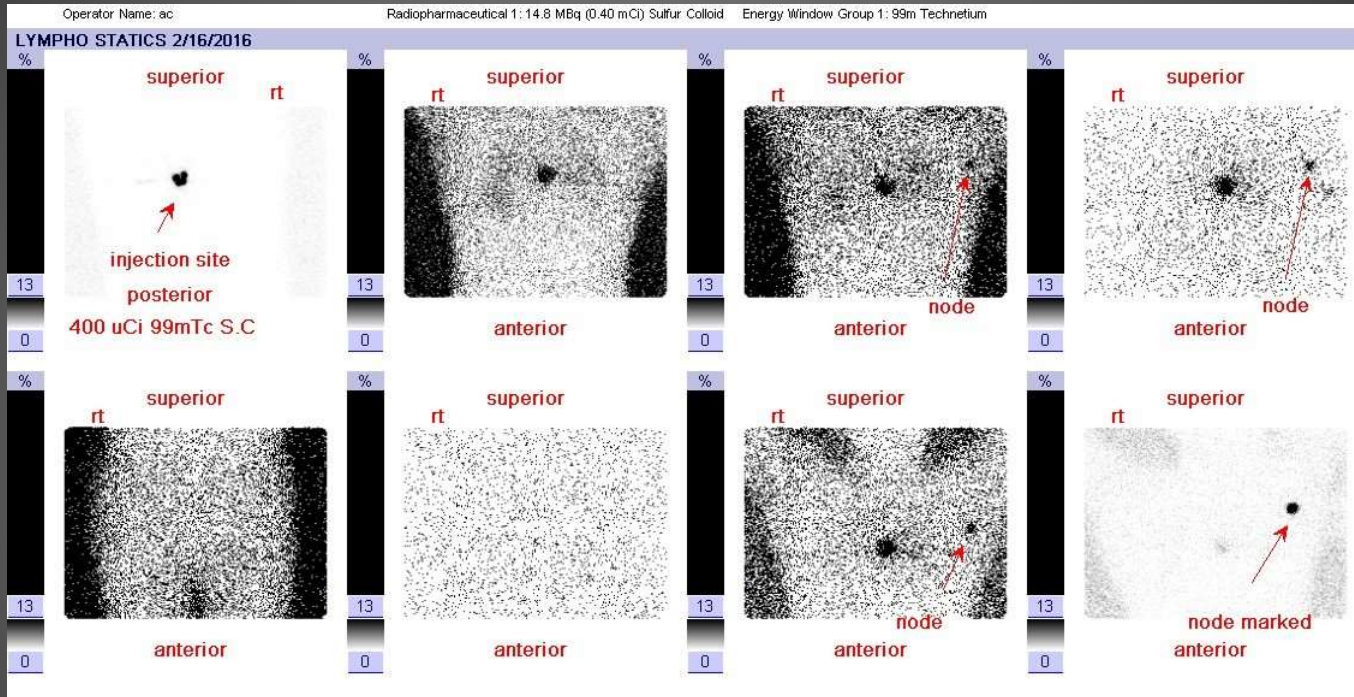
- *Radiopharmaceutical:*  $^{18}\text{F}$ Fluorine Fluorodeoxyglucose (FDG) IV
- *Technique:* PET/CT
- *Indications:* Primary and metastatic malignancy
  - Occasionally, infection or epilepsy
- *Need to Knows:* Recent chemotherapy, surgery, or radiation
  - *How recent? EANM guidelines suggest 10 days after chemo, 2 weeks after growth factors, 6 weeks after local surgery, and 2-3 months after radiation.*

LYMPHO STATICS 2/16/2016



# Lymphoscintigraphy

*Clinical Indication: 39yoM melanoma mid-back*

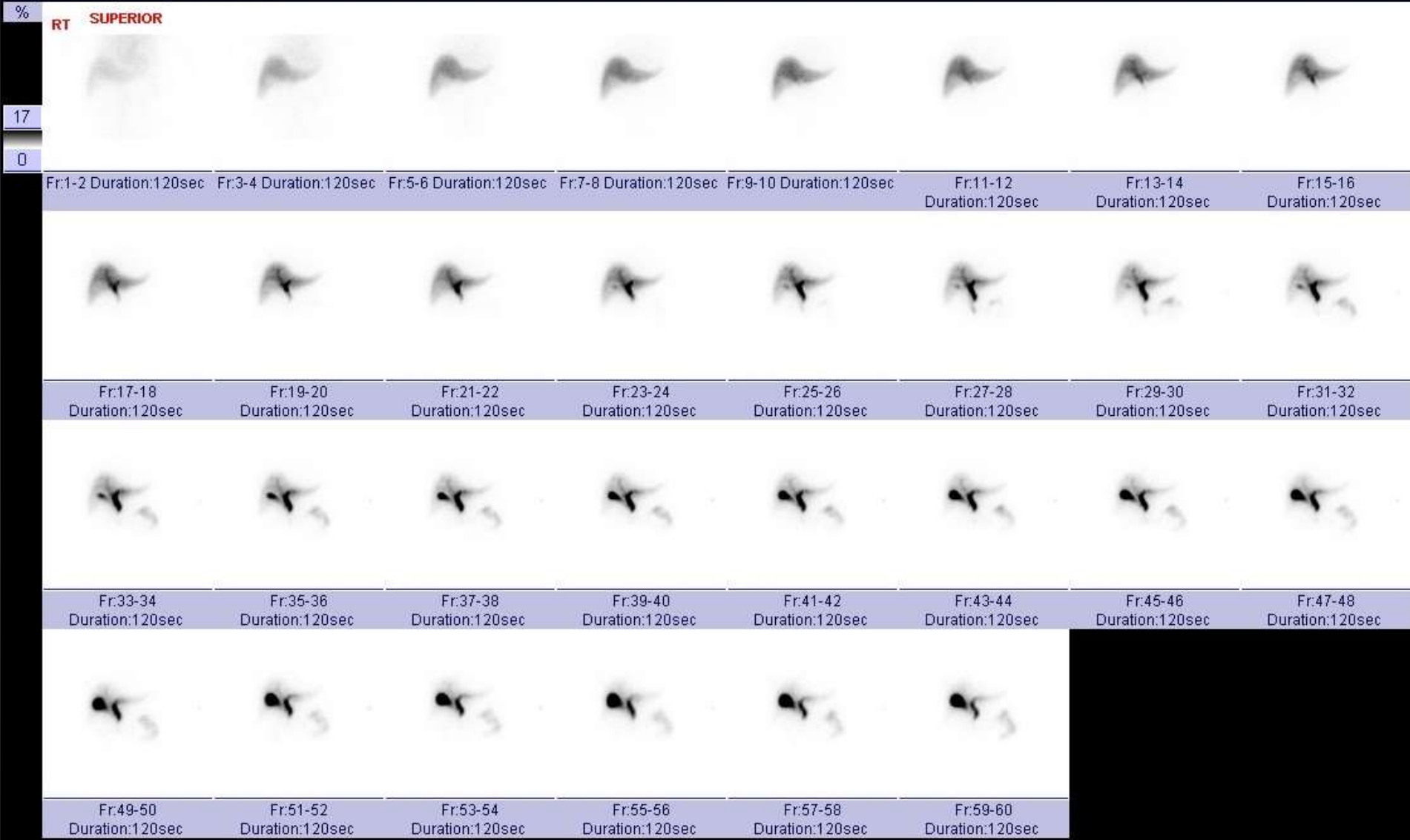


- Note activity in skin around the injection site and in LN
- Most commonly requested for melanoma to identify the sentinel lymph node
- *NB:* SNI injection ipsilateral breast periareolar for invasive breast cancer patients, no NM imaging (breast surgeons use gamma probe to identify LN)
- Search Pattern Tips: Nodes elsewhere? (axillae, inguinal, other)
- Critical Organ: Spleen

# Lymphoscintigraphy

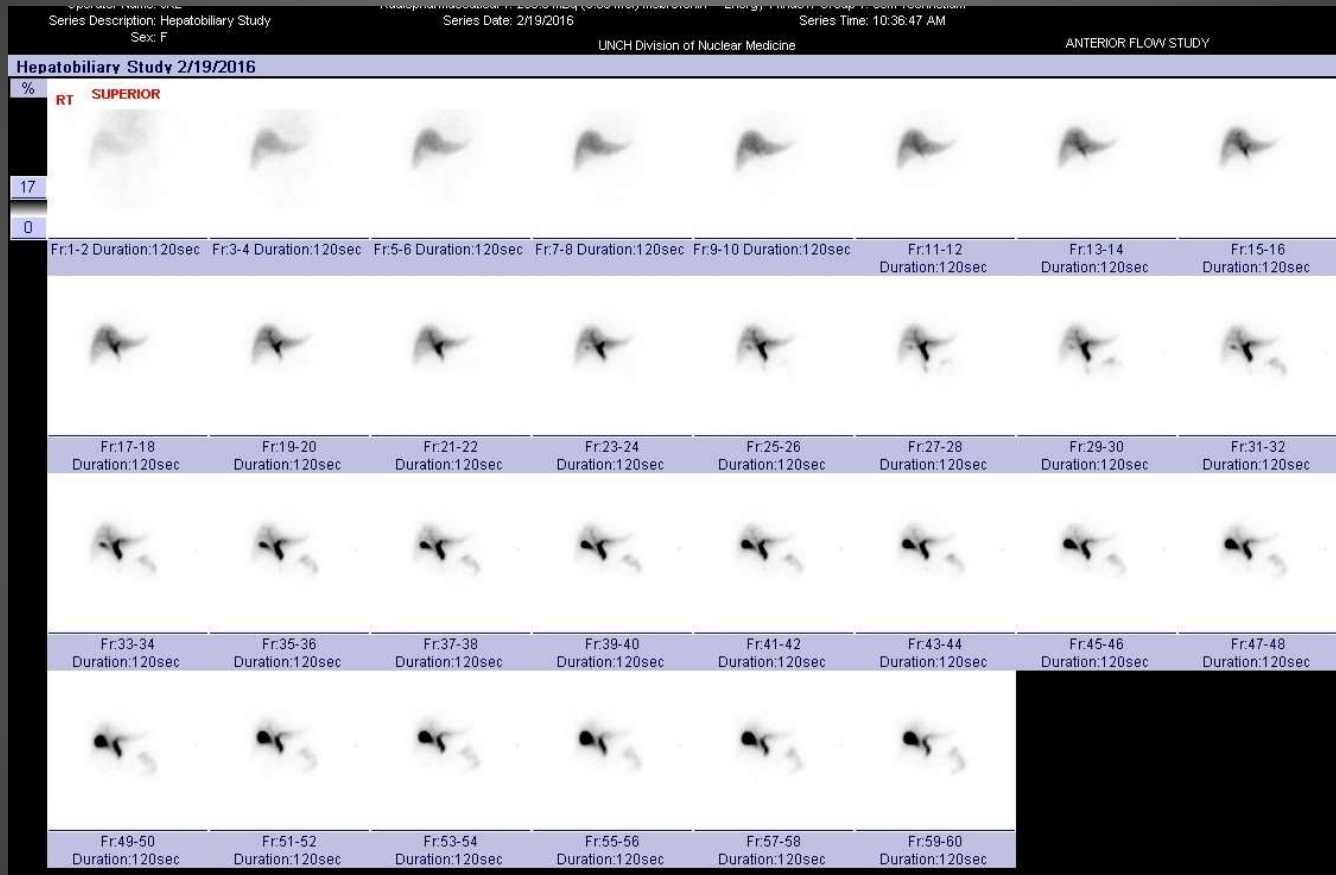
- *Radiopharmaceutical:*  $^{99\text{Tc}}$ Technetium Sulfur Colloid injection
- *Injection Techniques:* intradermal, peritumoral, and periareolar
  - Here, we will be doing **intradermal injections** for melanoma only; breast injections (which use the other two techniques) are done in mammo
- *Imaging and Localization Techniques:* planar and intraoperative gamma probe
- *Indications:* identification and localization of sentinel lymph node (SLN) for intraoperative gammaprobe-directed sampling
- *Need to Knows:* Injection site (**verify this before injecting!**  
Some surgeons have measurements from landmarks)
  - *Occasionally, prior radiation or chemotherapy will change drainage sites*

Hepatobiliary Study 2/19/2016



# Normal Hepatobiliary Scan

*Clinical Indication: 37yoM RUQ abdominal pain*



- Search Pattern Tips: Is there a gallbladder? Is it really a gallbladder?
- Critical Organ: Gallbladder

# Hepatobiliary Scan

- *Radiopharmaceutical:*  $^{99m}\text{Tc}$ Mebrofenin IV
- *Technique:* planar
- *Indications:* acute cholecystitis, chronic acalculous cholecystitis, common bile duct obstruction, biliary ectasia, bile leak, and postoperative complications
- *Pharmacologic protocols:* morphine sulfate and sincalide (CCK)
- *Quantitative analysis:* gallbladder ejection fraction (GBEF)
- *Need to Knows:*
  - NPO for 4-24 hours, off opioids for 8
  - Don't give morphine until you see the bowel
  - Don't give CCK after giving morphine
  - If you can't give morphine, you can wait 4 hours



		Parameter	99m Technetium
Bkgd Correction	On	Emptying	95 %
Decay Correction	On	Emptying begin (T0)	11 mins
Geometric Mean	On	Emptying end	181 mins
		T 1/2	80 mins
		T0 -> T 1/2	69 mins

PERCENT EMPTYING / NO CURVE FIT

Series Description: GASTRIC EMPTYING

Study Date: 3/3/2016

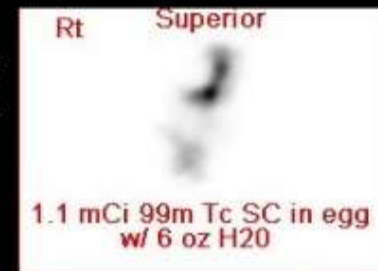
Study Time: 10:57:30 AM

Operator Name: mdh

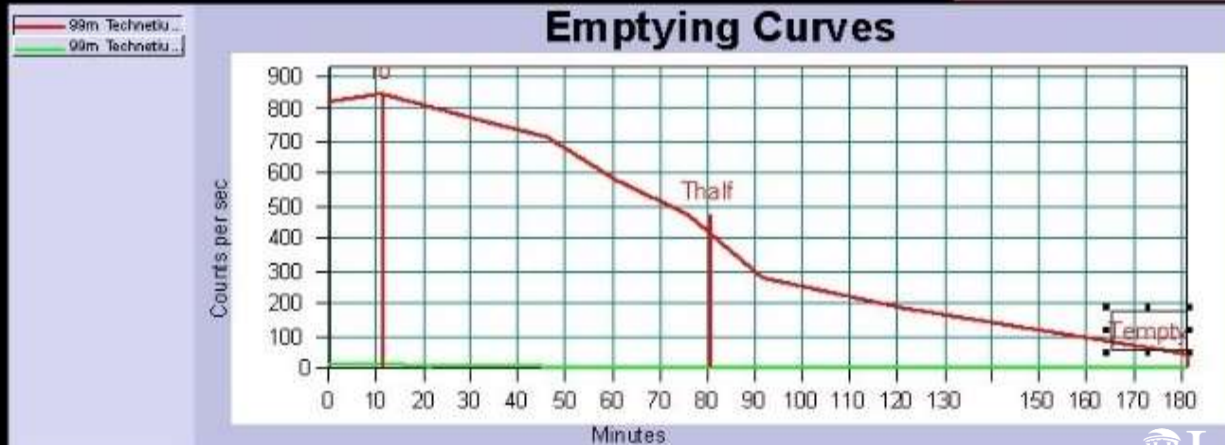
Radiopharmaceutical 1: 40.7 MBq (1.10 mCi) Sulfur Colloid

Energy Window Group 1: 99m Technetium

EMPTYING AT 60 MIN 32%  
 EMPTYING AT 90 MIN 67%  
 EMPTYING AT 2HRS 78%  
 EMPTYING AT 3HRS 95%

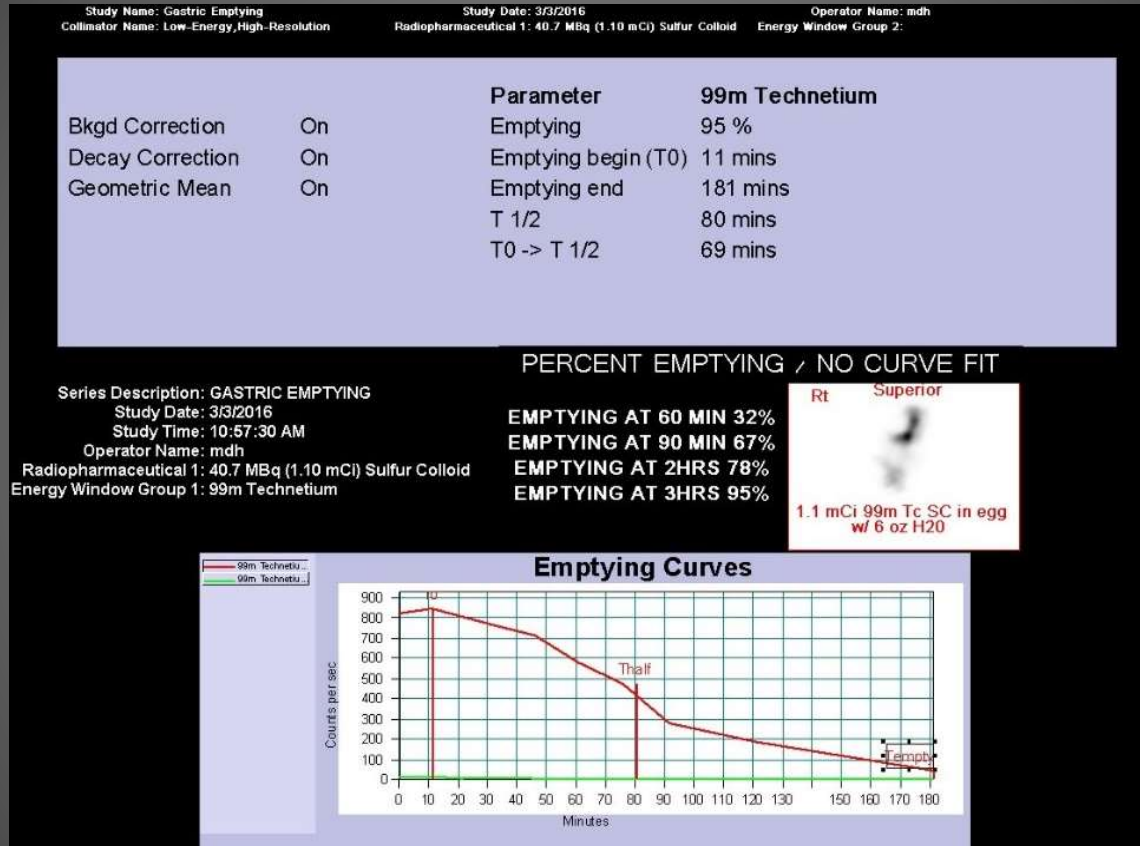


Emptying Curves



# Normal Gastric Emptying Exam

*Clinical Indication: 25yoF early satiety and vomiting*



- Search Pattern Tips: did they draw the ROIs correctly?
- Critical Organ: Colon

# ROIs

## GASTRIC EMPTYING (Results) 3/3/2016



All Images

GASTRIC EMPTYING

99m Technetium

40.7 MBq (1.10 mCi) Sulfur Colloid



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# Gastric Emptying Study

- *Radiopharmaceutical:*  $^{99}\text{Tc}$ Technetium sulfur colloid as solid meal (e.g. eggs)
- *Technique:* planar
- *Indications:* gastroparesis, gastroesophageal reflux, and aspiration
- *Quantitative analysis:* Quantitative analysis:  $T_{1/2}$ , 4-hour retained activity, and geometric mean methodology
- *Need to Knows:* Less than 40% emptying at 2 hours and 90% emptying at 4 hours means delayed emptying.
  - More than 70% emptying at 1 hour means rapid emptying.

Radiopharmaceutical 1: 906.5 MBq (24.50 mCi) Sestamibi    Energy Window Group 1: 99m Technetium

%  
103

Rt

Superior

Lt



ANTERIOR 15 MIN

0

%  
102

Rt

Superior

Lt



ANTERIOR 2 HOURS

0

# Parathyroid Exam

*Clinical Indication: 58yoF with hypercalcemia*

Radiopharmaceutical 1: 906.5 MBq (24.50 mCi) Sestamibi    Energy Window Group 1: 99m Technetium

%  
103

Rt

Superior

Lt



ANTERIOR 15 MIN

%  
102

Rt

Superior

Lt



ANTERIOR 2 HOURS

- Search Pattern Tips: Hot spot on 2-hour images in thyroid or mediastinum?
- Critical Organ: Gallbladder

# Parathyroid Scan

- *Radiopharmaceutical:*  $^{99m}\text{Tc}$  sestamibi
- *Techniques:* dual-phase, dual-tracer, planar, and SPECT-CT
- *Indications:* hyperparathyroidism (adenoma, hyperplasia, and ectopic)
- *Need to Knows:*
  - Other thyroid lesions? (thyroid nodules will also have persistent uptake on delayed images)
  - This is the same tracer used in cardiac (and uncommonly performed breast) scans.

# <sup>131</sup>Iodine Therapy

- *Radiopharmaceutical:* <sup>131</sup>Iodine Sodium Iodide PO, requires calculation of administered activity for benign vs malignant conditions
- *Patient Issues:* selection, preparation, informed consent, understanding and calculation of administered activity, counseling of patients and families on radiation safety issues, release criteria, and follow-up; pregnancy
- *Indications:* benign (hyperthyroidism), malignant (thyroid cancer remnant vs metastases)
- *Need to Knows:* Thyroid hormone withdrawal or thyrogen?
  - Did they go on a low-salt diet?
  - Make sure they are not pregnant!
  - Over 33 mCi → must talk to radiation safety





Ph:1-2 Fr:52-63 386K 51 sec Duration:99sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:64-75 1367K 150sec Duration:360sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:76-87 979K 8.5Min Duration:360sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:88-99 726K 14.5Min Duration:360sec  
128x128 Pix:4.8mm 99m Technetium

Table of Result Summary

Parameters	Left	Right	Total
Split Function (%)	52.3	47.7	
Kidney Counts (cpm)	38477	35092	73569
Renal Retention	0.205	0.351	
Time of Max (min)	4.001	3.501	
Time of 1/2 Max (min)	10.7	14.2	
Time from Max to 1/2 Max (min)	6.728	10.7	

Table of Result Summary

Parameters	Left	Right	Total
Split Function (%)	52.3	47.7	
Kidney Counts (cpm)	38477	35092	73569
Time of Lasts (min)			33.0
Time of 1/2 Lasts (min)	30.1	27.0	
Time from Lasts to 1/2 Lasts (min)	7.143	4.014	

Table of Result Summary

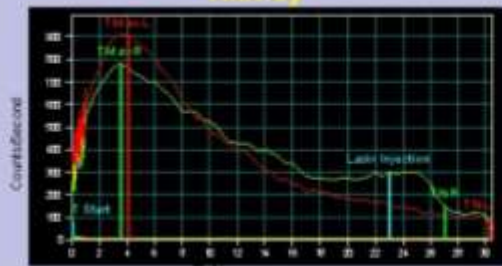
Parameters	Left	Right	Total
Split Function (%)	58.7	41.3	
Cortical Counts (cpm)	13817	9729.5	23546

Diuretic Renogram [Kidney] 3/8/2016



Kidney

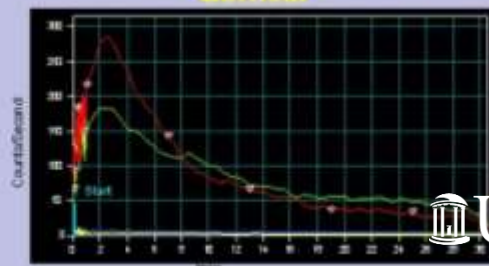
—Left—  
—Right—



Diuretic Renogram [Cortex] 3/8/2016

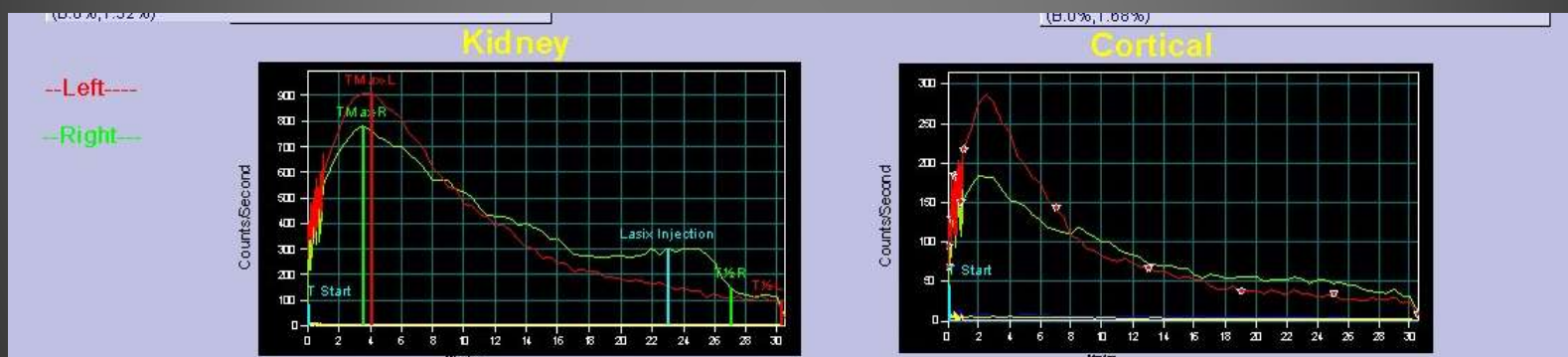
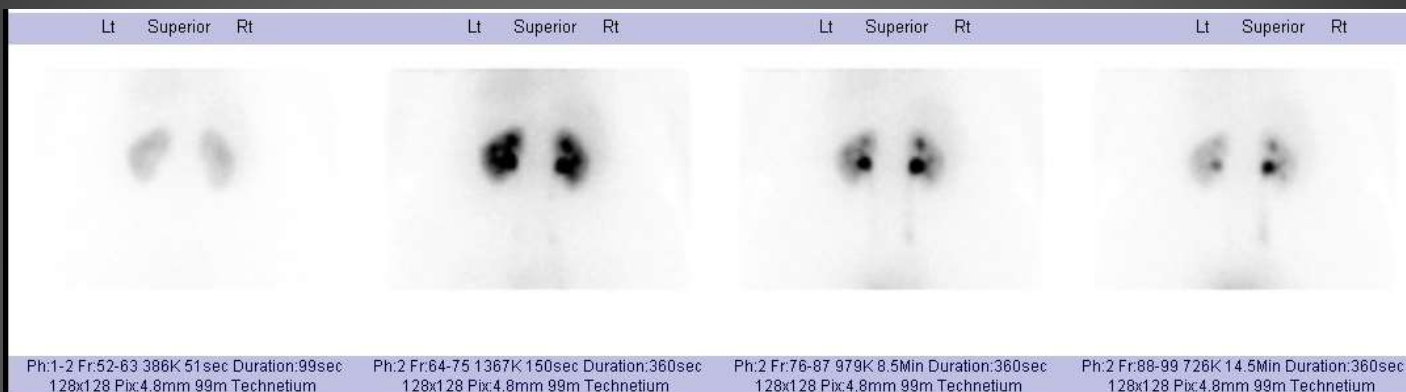


Cortical



# Diuretic renal scan

*Clinical indication: 46F with hydroureter*



- Search Pattern Tips: Do the kidneys clear on their own? How about after Lasix?
  - Unlike most radiology studies, right and left are not reversed; the scan is obtained posteriorly to decrease attenuation
- Curve is useful, but should first look at source images (can be mis-drawn, or patient may have motion)
- Critical Organ: Bladder

# Renal Nuclear Medicine Studies

## Diuretic Challenge

- *Radiopharmaceuticals*:  $^{99m}\text{Tc}$  MAG-3,  $^{99m}\text{Tc}$  DTPA
- *Technique*: planar
- *Pharmacologic protocols*: diuretics (e.g. furosemide)
- *Quantitative analysis*: relative renal function, and response to diuretic challenge
- *Indications*: obstructive vs nonobstructive hydronephrosis, and stent function
- *Need to know*s: This one is a little more of a process.
  - The patient is injected with MAG-3 (here), and imaged as the tracer passes through the collecting system.
  - If the patient excretes normally, the exam (can) end. The study is normal.
  - If the patient fails to excrete (the tracer stays in the collecting system), we give Lasix.
    - If the patient *still* fails to excrete, we call obstruction. Otherwise, the system is merely dilated.

# Renal Nuclear Medicine Studies

## Cortical

- \* *Radiopharmaceutical:*  $^{99m}\text{Tc}$  dimercaptosuccinic acid (DMSA)
- \* *Techniques:* planar, SPECT, and/or SPECT-CT
- \* *Quantitative analysis:* relative renal function
- \* *Indications:* relative function, scarring, and prenephrectomy assessment

## Perfusion and Function

- \* *Radiopharmaceuticals:*  $^{99m}\text{Tc}$  Mercaptoacetyltriglycine (MAG-3),  $^{99m}\text{Tc}$  DTPA
- \* *Technique:* planar
- \* *Quantitative analysis:* relative renal function, renogram, and glomerular filtration rate (GFR)
- \* *Indications:* renal dysfunction/failure, renal artery occlusion, and renal vein thrombosis

# Infection Nuclear Medicine Studies

## *<sup>67</sup>Gallium Citrate*

- \* <sup>67</sup>Ga cyclotron produced
- \* Administer IV
- \* T1/2 is 78 hours
- \* Used in infection and inflammation imaging
- \* Infrequently performed; still useful in some chronic infections
  - \* At UNC, still used for skull base osteomyelitis and otitis externa (due to proximity of the brain)

## *<sup>111</sup>In-WBC or <sup>99m</sup>Tc-WBC*

- \* <sup>111</sup>Indium Oxine Leukocytes IV
- \* <sup>99m</sup>Technetium hexamethylpropyleneamine oxime (HMPAO = Ceretec) Leukocytes IV
- \* Used in abscess, osteomyelitis, cellulitis, synovitis/arthritis, septic joint, hardware infection
- \* <sup>99m</sup>Tc-WBC more economical, allow for higher administered dose, better visualization of small parts. BUT physiologic excretion of <sup>99m</sup>Tc may reduce sensitivity
  - \* Classically, <sup>99m</sup>Tc is used in the extremities and <sup>111</sup>In in the trunk.

Sex: F

Referring MD: NAROTAM^VINAY^K^

Series Time: 1:58:54 PM

Collimator Name: Low-Energy,High-Resolution

Energy Window Group 1: 99m Technetium

UNC Hospitals Division of Nuclear Medicine

Rt Superior Lt Lt Superior Rt Rt Superior Lt Lt Superior Rt

%

%

%

%



28

33

57

68

0

0

0

0

Anterior 1596K Duration:747sec 256x1024 Pix:2.4mm 99m Technetium

Posterior 1313K Duration:747sec 256x1024 Pix:2.4mm 99m Technetium

Anterior 1596K Duration:747sec 256x1024 Pix:2.4mm 99m Technetium

Posterior 1313K Duration:747sec 256x1024 Pix:2.4mm 99m Technetium

# Pediatric Nuclear Medicine Studies

## *Most common at UNC*

- \* Bone scan
  - \* Similar to bone scans in adults, the main application being neuroblastoma
  - \* Often done with MIBG scan
  - \* Be aware of growth plates
- \* Gastric emptying study
  - \* Similar to adults, sometimes a liquid study is done
- \* DMSA
  - \* This is usually a pediatric study
  - \* Looks for scarring; hydronephrosis often visible
- \* Diuretic renal (MAG-3) scan
  - \* Interpreted similarly (normal/dilation/obstruction)
  - \* However, patient usually has a Foley and is hydrated beforehand

# CNS Nuclear Medicine Studies

## BRAIN PERFUSION

- \* *<sup>99m</sup>Techneium Ceretec IV*
- \* Techniques: planar, SPECT, and/or SPECT-CT
- \* Indication: confirmation of clinical brain death, epilepsy
- \* Prompt activity in the brain and sagittal sinus effectively rules out brain death
- \* In epilepsy, uptake is increased ictally and decreased interictally at the seizure focus

## CSF / SHUNT

- \* *CSF FLOW* *<sup>111</sup>Indium Diethylenetriamine Pentaacetic (DTPA)* Intrathecal Injection
- \* Techniques: planar, SPECT, and/or SPECT-CT
- \* Indication: normal pressure hydrocephalus
- \* *SHUNTOGRAM* *<sup>99m</sup>Techneium DTPA* Injection into shunt reservoir
- \* Techniques: planar, SPECT, and/or SPECT-CT
- \* Indication: V-P shunt patency



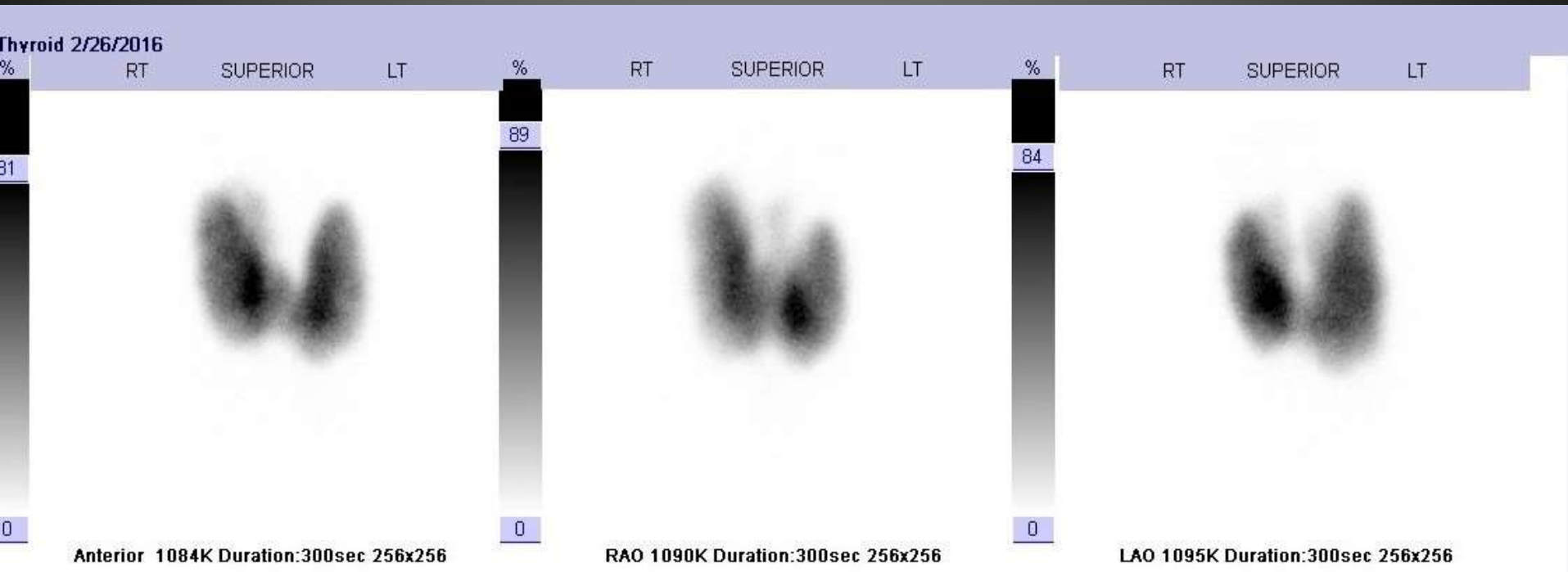
# More Nuclear Imaging Intel . . .

- Most studies use Tc-99m as radionuclide, with 140 keV photon and 6-hour half-life.
  - PET scans use F-18, with 511 keV photons (produced from positron annihilation) and a 108-minute half-life.
  - Some other common nuclides used at UNC are:
    - In-111, 171 keV and 2.8 days
    - Xe-133, 81 keV and 5.24 days
      - Xenon's half-life is actually much less in biological terms because it is exhaled.
    - I-123, 159 keV and 13.3 hours
    - I-131, 364 keV and 8.02 days
- Radioactive decays are exponential, so after two half-lives, one-quarter of the radioactivity is left, and after three, one-eighth.
- If you are doing two scans, the **lower-energy photon is done first**. The reason is that photons will lose energy on their track throughout the body (attenuation) and a higher-energy radionuclide may be confused with a lower-energy radionuclide.
  - This is why we do ventilation before perfusion in a V/Q scan. (We would prefer to do the perfusion scan first and cancel the ventilation scan for a normal patient, but persistent Tc-99m would 'downscatter' into the Xe-133 window).

# Case-based Q&A of six 'Aunt Minnies'

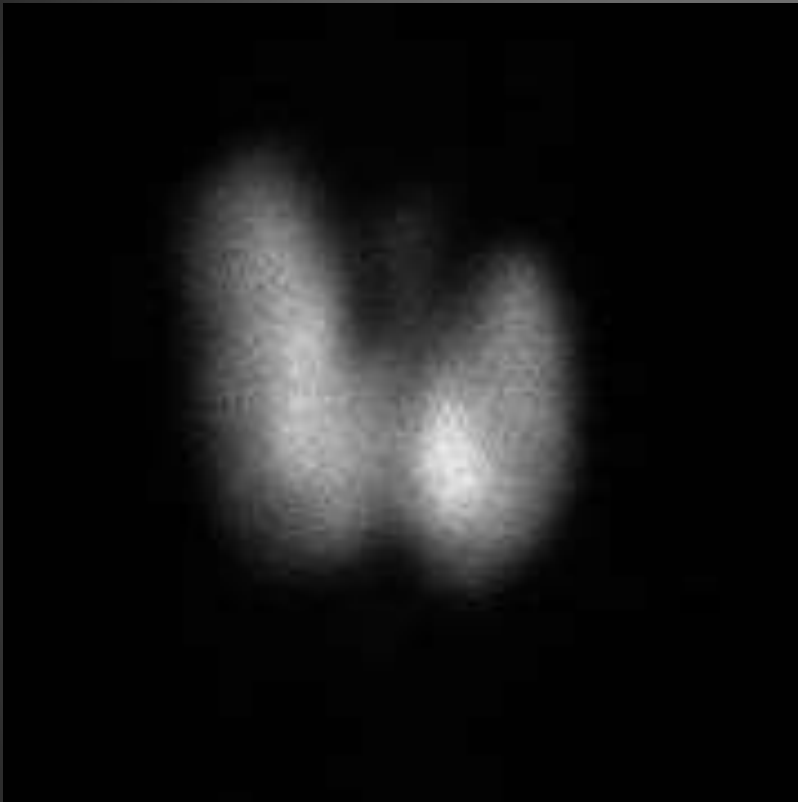
# Case #1

*Clinical Indication: 41yoF hyperthyroidism*



$^{131}\text{I}$  24 hour Thyroid uptake = 68%. (Normal range = 15-35% at 24 hrs)

# Case #1 Graves Disease



- Often treated with I-131 therapy
  - Note that this destroys the thyroid, so check with clinician beforehand or make sure the patient is definitely scheduled for therapy beforehand
    - Why not give just enough to make them neither hypothyroid nor hyperthyroid? Eventually they become hyperthyroid again
    - Why not just use thyroid-suppressive drugs like methimazole or propylthiouracil? More side effects over the long term
- Often empirically chosen at 10-15 mCi

*Q. If the thyroid uptake is verified at 3%, how much radioiodine therapy would you administer?*

1. 0 mCi
2. 10 mCi
3. 50 mCi
4. 200 mCi

*A. If the thyroid uptake is verified at 3%, how much radioiodine therapy would you administer?*

1. 0 mCi

A 3% uptake suggests subacute thyroiditis, which is a self-limiting thyroiditis, thought to be viral, and is *not* treated with radioactive iodine. In practice the images would be different as well.

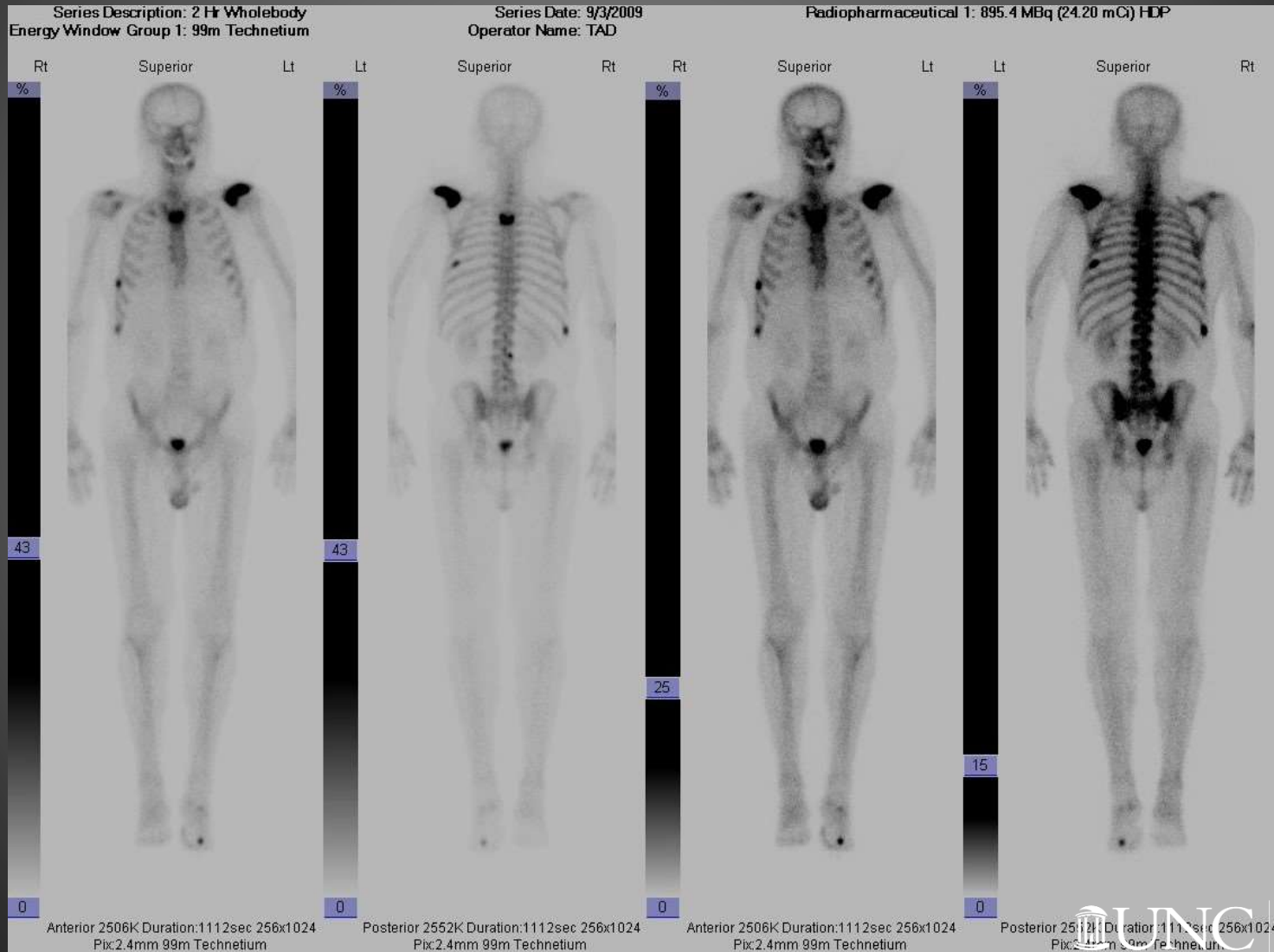
2. 10 mCi

3. 50 mCi

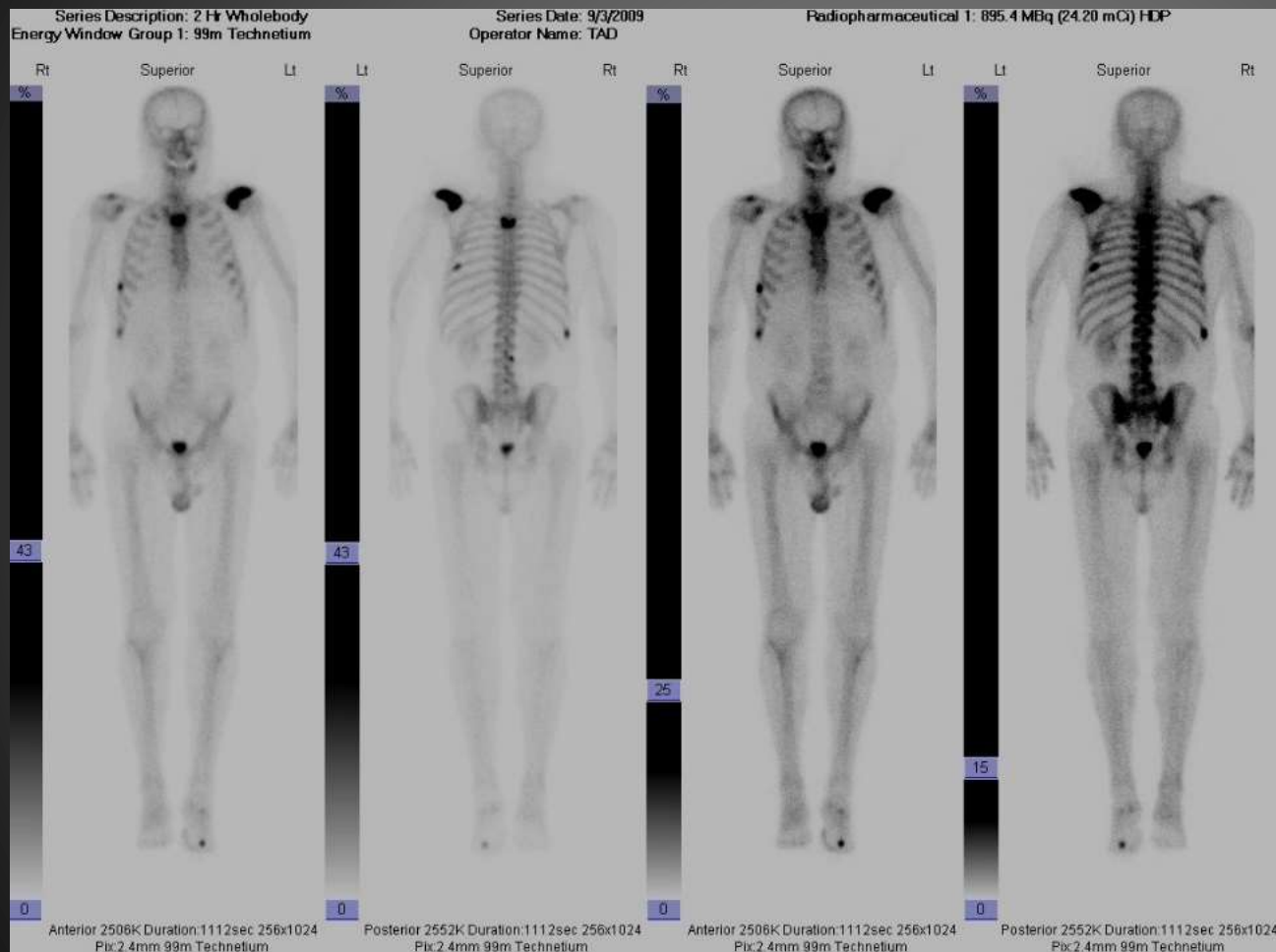
4. 200 mCi

# Case #2

*Clinical Indication: 74yoM history of prostate cancer*



# Case #2 Bone Metastases

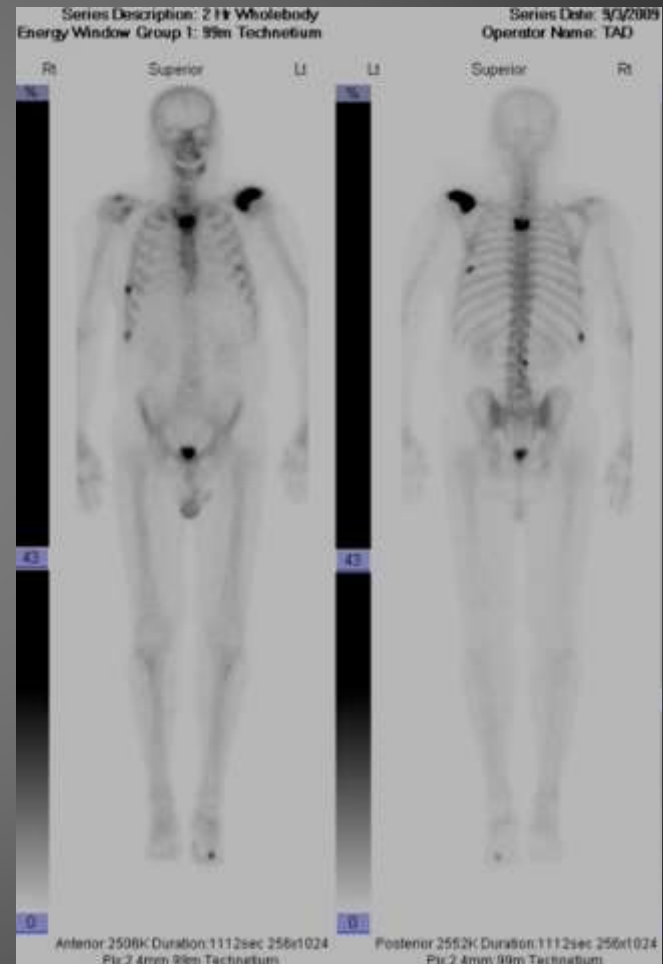


- Fractures and other traumas will tend to be in an appropriate distribution—linear, for example
- Osteomyelitis will tend to be localized to a focal area—feet, spine
- Degenerative disease is at the joints
- Metastases favor the axial and proximal appendicular skeleton—'red marrow box'



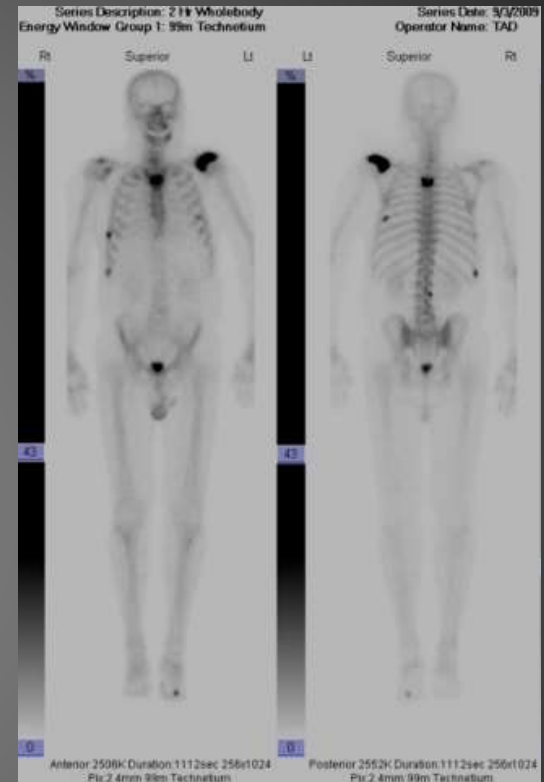
*Q. Which of these bone scan lesions is most likely to be benign?*

1. Scapula
2. Spine
3. Rib
4. Toe



*A. Which of these bone scan lesions is most likely to be benign?*

1. Scapula
2. Spine
3. Rib
4. Toe



While metastases can occur anywhere in the skeleton, we tend to be somewhat more suspicious of metastases outside the axial and proximal appendicular skeleton. The exceptions are lung cancer and melanoma—for which bone scans are rarely obtained.

# Case #3

*Clinical Indication: 21yoM recently biopsied mediastinal mass*



## Case #3 Positive PET



- The 'hot' supraclavicular and paraspinal areas actually likely represent brown fat, a heat-generating tissue that uses a lot of glucose
- The brain and heart and bladder (and to a lesser extent, kidneys, liver, and bone marrow) have a low level of physiologic uptake.
- The hot masses in the chest don't have a physiologic explanation, so...

*Q. The most likely diagnosis is*

1. Brown fat
2. Infection
3. Lymphoma
4. Normal scan

*A. The most likely diagnosis is*

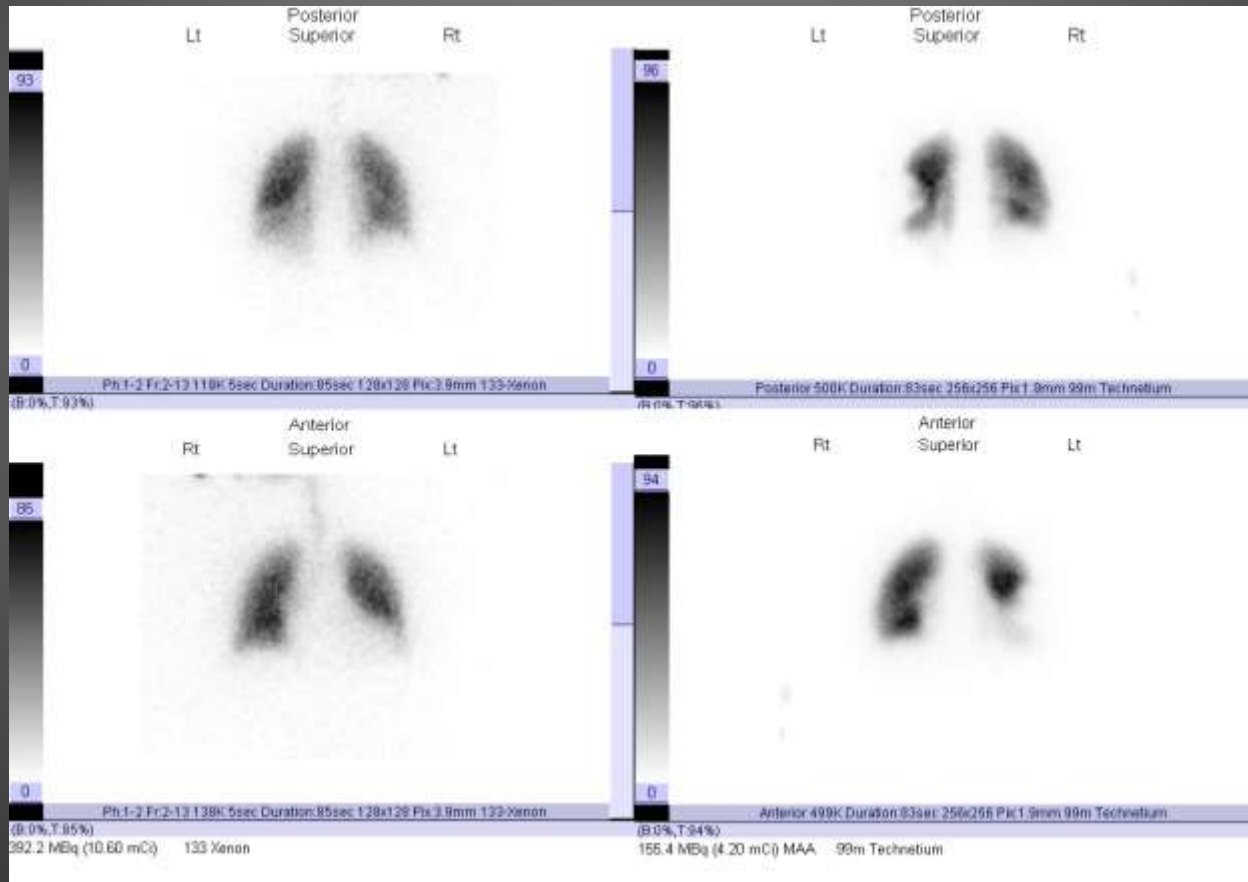
1. Brown fat
2. Infection
3. Lymphoma

While the bilaterally symmetric uptake in the supraclavicular region is consistent with brown fat, the enlarged, FDG-avid masses in the chest are consistent with lymphoma.

4. Normal scan

# Case #4

*Clinical Indication: 53yoF breast cancer pt with SOB*



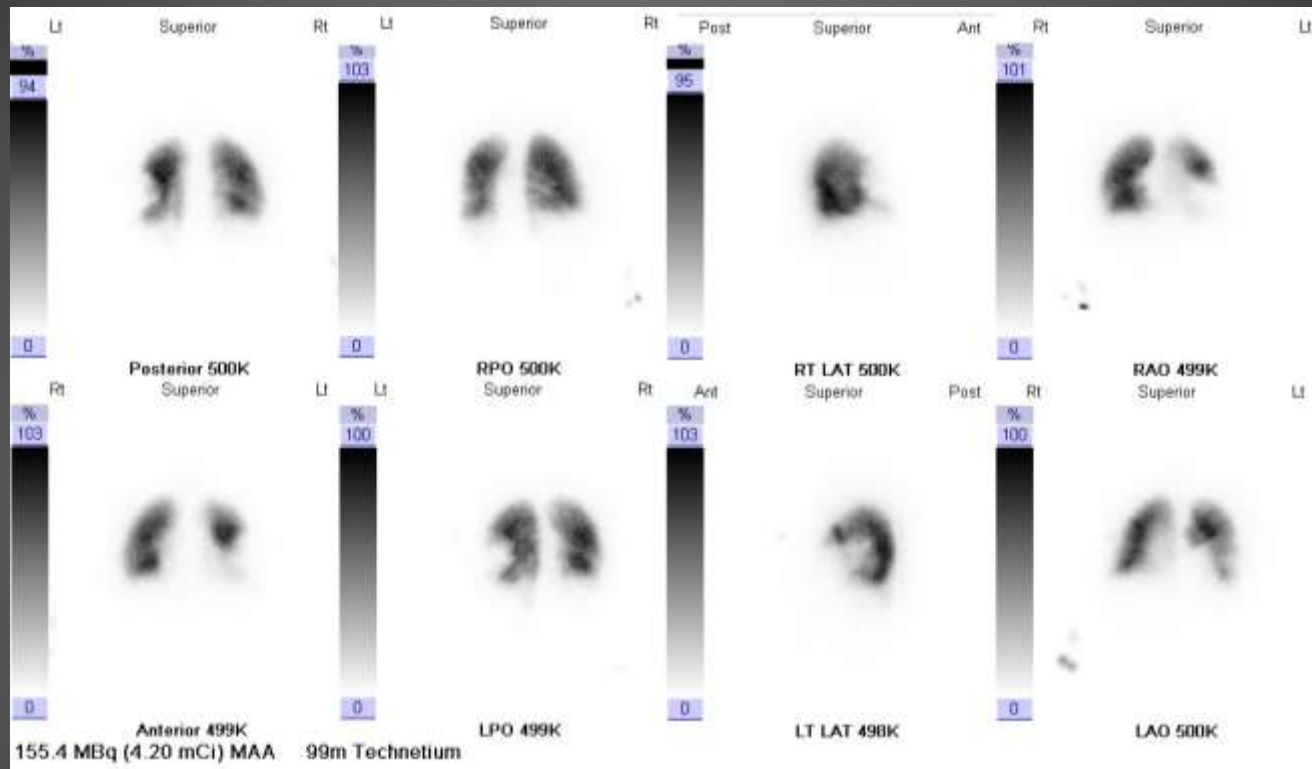
VENTILATION

PERFUSION



SCHOOL OF MEDICINE  
Radiology

# Case #4 Pulmonary Embolism



- Multiple defects in the lingula and basilar segments.
- These are NOT matched to ventilation defects.



*Q. Critical organs for the Ventilation and Perfusion scan radiopharmaceuticals are respectively*

1. trachea and lungs.
2. lungs and liver.
3. trachea and liver.
4. lungs and lungs.

*A. Critical organs for the Ventilation and Perfusion scan radiopharmaceuticals are respectively*

1. trachea and lungs.
2. lungs and liver.
3. trachea and liver.
4. lungs and lungs.

# Case #5

*Clinical Indication: 74yoM RUQ abdominal pain, normal GB US*



# Case #5 Cholecystitis



- The gallbladder is not seen.
- Once the bowel is visible, we can try giving morphine to contract the sphincter of Oddi
  - If the gallbladder shows up after morphine, we may have chronic cholecystitis, but acute cholecystitis has been ruled out.
  - What if we don't see the bowel (or the patient can't get morphine)? We can also wait 4 hours
- If you don't see the bowel, you can try a fatty meal or CCK (if morphine not given, and you have no suspicion of CBD obstruction—see below).
- If you *still* don't see the bowel (but you do see the bile duct), you might think about partial CBD obstruction. If you don't see the bowel or the bile duct, you might think about complete CBD obstruction or poor liver function.

*Q. During a Hepatobiliary Scan, the Morphine Sulfate is administered intravenously*

1. at any time during the exam.
2. immediately following visualization of the GB.
3. at 60 minutes if GB is nonvisualized.
4. at 60 minutes if GB is nonvisualized, with tracer in bowel.

*A. During a Hepatobiliary Scan, the Morphine Sulfate is administered intravenously*

1. at any time during the exam.
2. immediately following visualization of the GB.
3. at 60 minutes if GB is nonvisualized.
4. at 60 minutes if GB is nonvisualized, with tracer in bowel.

# Case #6

*35yoF with ureteropelvic junction obstruction*

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Lt Superior Rt

Lt Superior Rt

Lt Superior Rt

Lt Superior Rt



Ph:2 Fr:73-75 724K 7Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:76-78 694K 8.5Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:79-81 669K 10Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

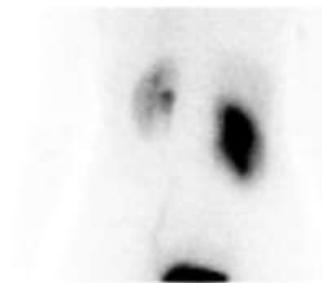
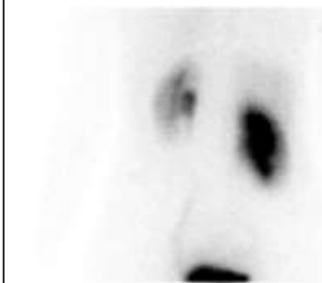
Ph:2 Fr:82-84 653K 11.5Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

Lt Superior Rt

Lt Superior Rt

Lt Superior Rt

Lt Superior Rt



Ph:2 Fr:85-87 644K 13Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:88-90 639K 14.5Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:91-93 635K 16Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

Ph:2 Fr:94-96 632K 17.5Min Duration:90sec  
128x128 Pix:4.8mm 99m Technetium

*Q. What is your next step?*

1. Nothing, the study is normal.
2. Nothing, there is high-grade obstruction.
3. Give Lasix to differentiate between high-grade obstruction and a dilated collecting system on the right
4. Give Lasix to differentiate between high-grade obstruction and a dilated collecting system on the left



*Q. What is your next step?*

1. Nothing, the study is normal.
2. Nothing, there is high-grade obstruction.
3. Give Lasix to differentiate between high-grade obstruction and a dilated collecting system on the right
  - The kidney isn't clearing; if it clears with Lasix, this is just dilation, whereas if it doesn't, this is a high-grade obstruction. Right is right on a renal scan!
4. Give Lasix to differentiate between high-grade obstruction and a dilated collecting system on the left.

retic Renoqram 3/10/2016



- Post Lasix administration, the right kidney clears; this is not a high-grade obstruction

# Think Back

- Common NM examinations at UNC

WB Bone V/Q PET Thyroid WB Thyroid Hepatobiliary  
Gastric Emptying Parathyroid <sup>131</sup>Iodine Therapy Diuretic

- Radiopharmaceutical, Technique, Indications to include normal exams and Need To Knows

- Case-based Q&A of six Aunt Minnies

Graves Disease Bone Mets M1 Disease PE Cholecystitis  
Hydronephrosis without obstruction