Lecture 3:

Nuclear medicine in oncology

Radiology Team
Med433

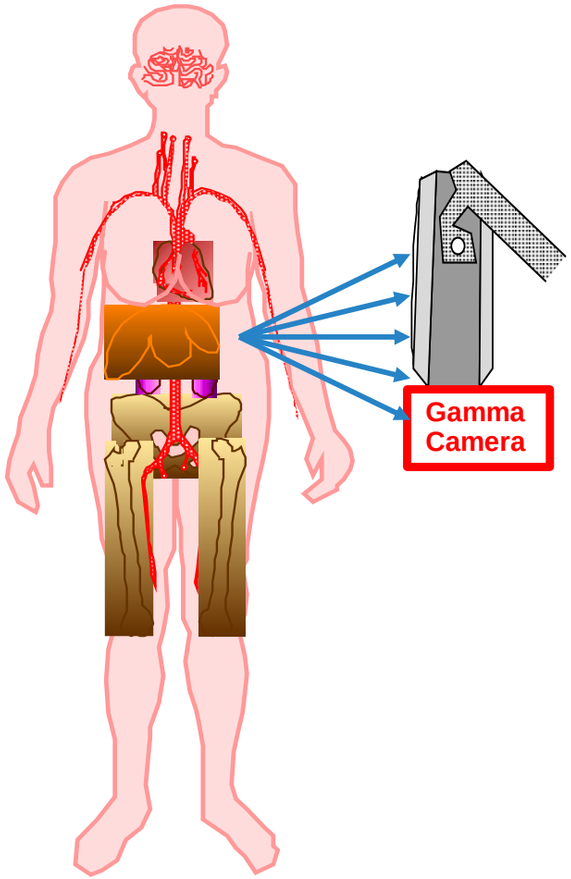
● Slides ● Explanation ● Notes ● Additions ● Important

Objectives

- **What are the tumor imaging and therapeutic radiopharmaceuticals?**
- **What are the nuclear medicine tumor imaging methods?**
- **What are the objectives of tumor imaging?**
- **What are the potential values of nuclear medicine tumor imaging methods?**
- **What is the role of nuclear medicine in the treatment of tumors?**

Nuclear Medicine Procedure

- Patient injected with small amount of radioactive material .
- Radiopharmaceutical localizes in patient according to metabolic properties of that drug.
- Radioactivity decays, emitting gamma rays.
- Gamma rays that exit the patient are imaged.



What are the nuclear medicine tumor imaging methods?

1)PLANAR / SPECT

2)SPECT CT

3)PET CT

How to differentiate between radiology and nuclear medicine?
-In nuclear medicine: the machine "gamma camera" is detecting the radiation emitting from the patient.
-In radiology: the machine will give radiation to the patient .
In nuclear medicine you need : radioactive material + gamma camera .

Radiopharmaceutical means :
Radio > radiation
Pharmaceutica > Specific agent for a specific organ

Physical Properties SPECT Radionuclides

Radionuclide	T/2 physical	Type of radiation	E(kev)
Technitium 99m(Tc-99m)	6 hrs	Gamma	140
Iodine I131	8 days	Gamma/ Beta	364/606
Iodine I123	13.2 hrs	Gamma	159
Gallium Citrate(Ga-67)	78.3 hrs	Gamma	90,190,290
Thallium Chloride 201 (Tl201)	73.1 hrs	X-ray	68-83
Indium 111 (In 111)	2.8 days	Gamma	173,247
Xenon 133	5.2 days	Gamma	81
Kripton 81m	13 secs.	Gamma	190

T/2 : Half life

Physical Properties of positron emitting (PET) Radionuclides

Radionuclide	T/2 physical (**min**)	positron energy	Productivity
Carbon 11	20	0.96	accelerator
Nitrogen-13	10	1.19	accelerator
Oxygn-15	2	1.73	accelerator
Fluorine 18(the gold standard)	110	0.635	accelerator
Gallium 68	68	1.9	generator (germanium 68)
Rubidium 82	1.3	3.15	generator (strontium-82)

Tumor Metabolic properties

- Increased **vascularization**
- Increased **capillary permeability**
- Newly **proliferated capillaries**
- Increased **blood flow**
- Metabolically **active cells** (Patient has weight loss due to consume of glucose by tumor)
- Increased **energy demand**

Tumor Specific useful properties

- High density of some common receptors.
- Expression of several specific receptors (endocrine tumor has somatostatin receptor).
- Expression of some specific tumor antigenes.

All these properties could be used for imaging and therapy

Tumor Non-specific Diagnostic radiopharmaceuticals

(Can detect the site of tumor but cant detect which type of tumor it is which means it demonstrates tumor sites but are not specific for malignancy)

1)PET or PET-CT:

- F-18 FDG (Fluorodeoxyglucose)– anaerobic metabolism

2)Planar, SPECT or SPECT-CT:

- Diphosphonates – bone scan (Reveal metastasis but cant tell what is the origin of the tumor)
- Ga-67 citrate – similar to FDG – localising agent
- Tc99m Nanocolloid – bone marrow scan
- Tc99m MIBI / Thallium 201 – several tumors

Tumor Specific Diagnostic radiopharmaceuticals

(Binds directly to special tumor antigens or receptors or are accumulated by special metabolic pathway)

1)PET or PET/CT:

- Gallium -68–octreotide analogues (Ga-68 DOTA): For neuroendocrine tumors
- Fluorine -18-fluorodeoxythymidine(F-18-FLT): For tumor proliferation
- Fluorine -18-fluoromisonidazole(F-18-FMISO): For tumor hypoxia

2)Planar, SPECT or SPECT/CT: (Based on iodine so give iodine along with one of these agents)

- I-123/131 MIBG for neuroendocrine tumours
- I-131 for differentiated thyroid carcinomas
- In-111 or Tc99m octreotide for tumours expressing somatostatin receptors.
- Monoclonal antibodies labelled with In-111, I-123/131 or Tc-99m.

Therapeutic radiopharmaceuticals

Non-specific (In case of wide spread bone metastasis give one of these agent to control symptoms)

- Sr-89, Sm-153, Re-189
- Bone pain palliation

Patient with sever bone metastasis and sever pain not responding to morphine we give sr-89 these will go to the bone metastasis and will kill it

Specific

- I-131

  Thyroid cancer as specific diagnostic if tumor significantly accumulates

- Y (Yttrium)-90

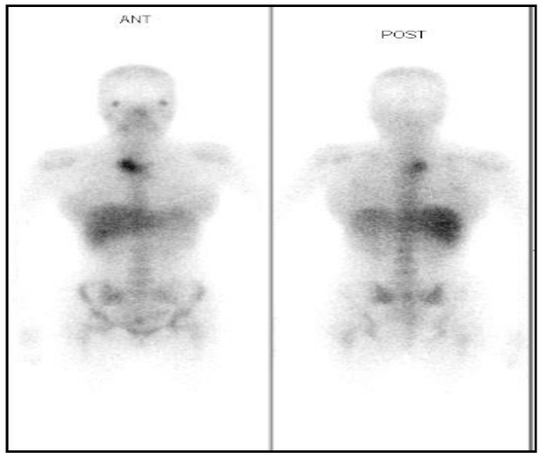
  Zevalin – monoclonal antibody for B-cell lymphomas

NM Imaging modalities (Planar Imaging)

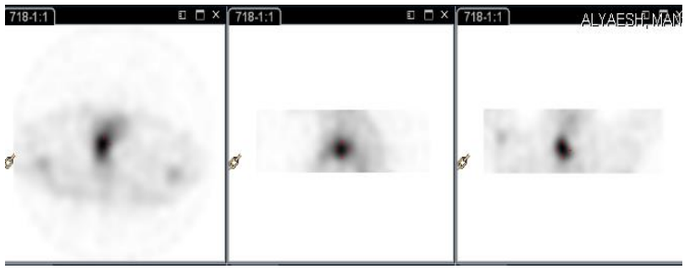
2 Dimensions : Horizontal and perpendicular

NM Imaging modalities

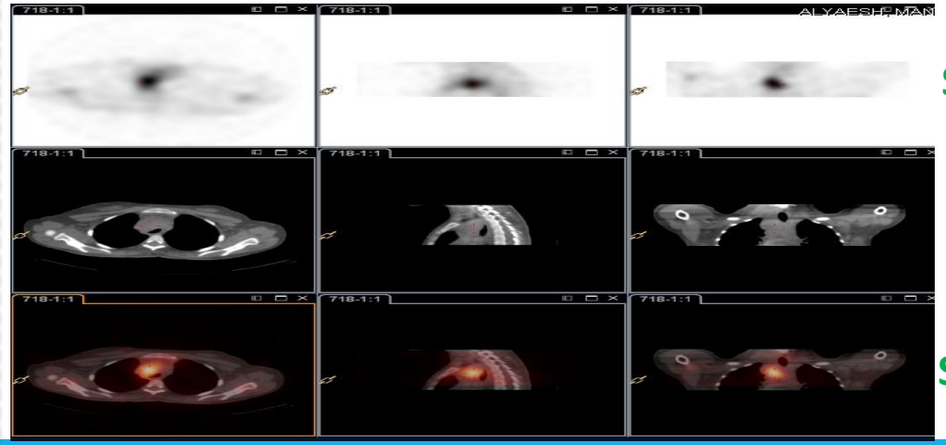
Single Photon Emission Computed Tomography (SPECT) and SPECT CT



Whole Body Gallium Scan (Planar Image)



SPECT

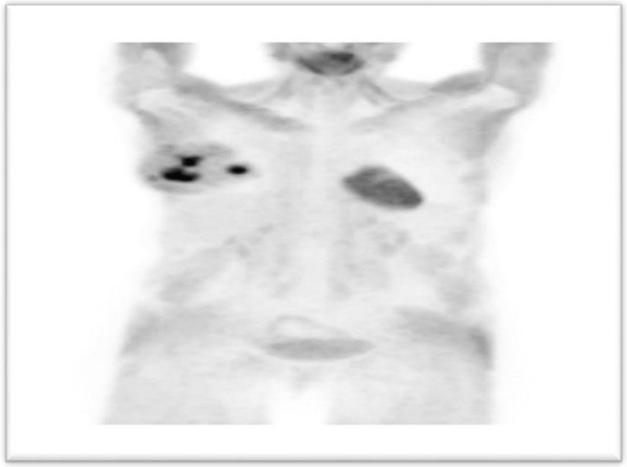


SPECT

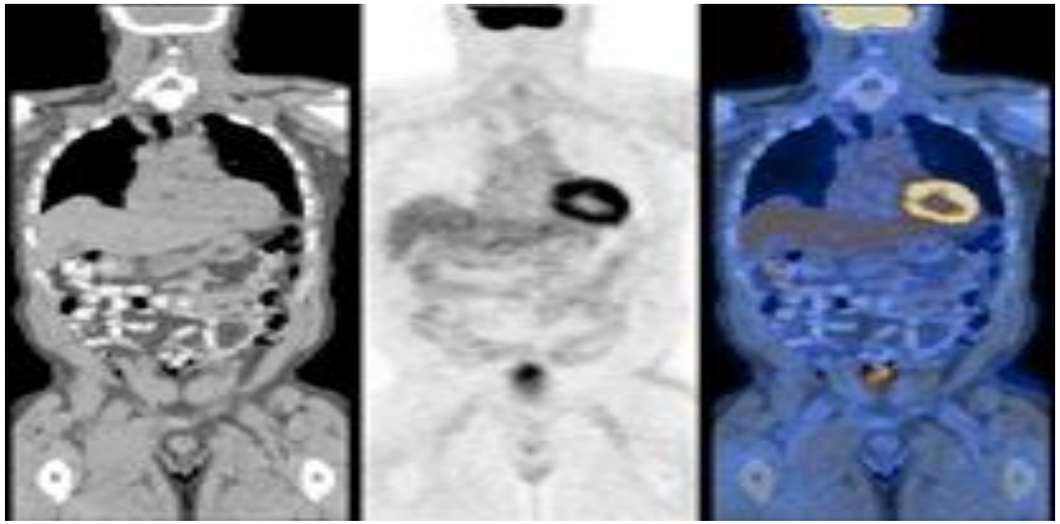
CT

SPECT + CT

NM Imaging modalities Positron Emission Tomography (PET) and PET CT



PET



CT PET PET + CT

Role for Nuclear Medicine In Oncology

Diagnosis :Specific or non-specific
Staging : Important for proper therapy
Follow-up : Early detection of recurrence
Treatment : Specific or non-specific

Summary

Tumor Imaging

Non specific tumor imaging agents:

- Tc-99m MDP bone scan: Detection and follow up of bone metastasis
- Gallium 67 : Staging ,Restaging & therapy assessment of HD , NHL , Lung cancer .
- Thallium 201 : Tumor viability & tumor seeking.
  {Tc-99 m Agents (MIBI ,TETRO)
- F18 – FDG : Staging ,Restaging & therapy assessment of HD , NHL , Lung cancer .

Specific tumor imaging agents:

- In–111 (TC99m) Octreotide : Neuroendocrine tumors
- I -123 MIBG : Neuroendocrine tumor
- I -131 : Lung mets. thyroid carcinoma

Bone scan "Procedure"

- Radiopharmaceuticals: Technitium 99m Methylene DiPhosPhonate (Tc-99m MDP).
- Tissue accumulation depends on :
  1) blood flow
  2) capillary permeability
  3) metabolic activity of osteoblasts and osteoclasts
  4) mineral turnover
- Dose: 500 to 800 MBq (Megabequerel) / 15- 20 mCi (millicurie)
- Imaging time: 2 to 3 hours postinjection – WB + SPECT
- Potentials of bone scan: Positivity many months before an abnormality can be detected on X ray.

Bone scan in oncology indications

I- Metastatic Disease: Lung cancer, prostate, breast, thyroid, and renal tumours

- Diagnosis.
- Initial staging.
- Restaging.
- Asses response to therapy.

II- Primary Bone Tumors :

- Malignant or Benign
- Therapy planning for patients with primary bone malignancy (e.g. Osteogenic & Ewings sarcoma)

III- Soft tissue tumors :

- Primary
- Metastases

Bone Scan In Oncology Imaging features

A. Hot lesions : Majority of bone tumors. (Dark spot)

B. Cold lesions : Purely osteolytic tumors (renal cell carcinoma, thyroid cancer, anaplastic tumors),radiation therapy (White spot)

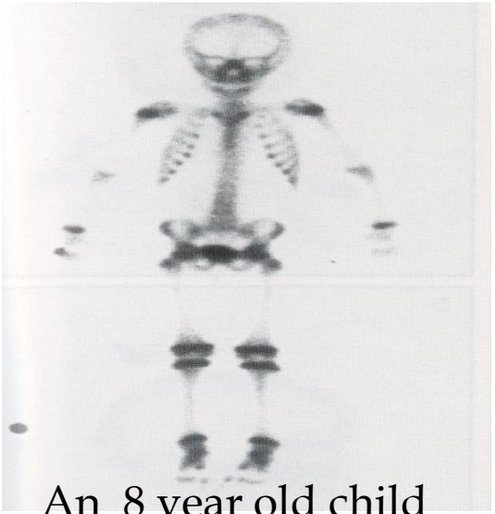
C. Superscan : Diffuse increased skeletal uptake with no soft tissue or kidney activity (e.g. CA prostate ,breast ,..etc).

D. Normal distribution : Marrow tumors (e.g. lymphomas, leukemia, multiple myeloma). (Limited to bone marrow)

E. Soft tissue uptake : Soft tissue tumors may concentrate the tracer.(Any tissue which has calcium such as calcification of breast cancer)

F. Flare phenomenon – increased number of lesions in the case of effective therapy. (Good response to treatment)

Normal Whole Body Bone scan



An 8 year old child

A 25 yrs old adult

Bone Scan : In Metastatic Disease

1)Access of Nonosseous Tumors To Bone:

- Direct Extension.
- Retrograde venous flow.
- Arterial Circulation (after venous or lymphatic access).

2)Epithelial Tumors:

- Reach red marrow of axial skeleton via venous and arterial flow.
- Distribution of red marrow in adult : calvarium, spine , pelvis , and proximal femurs and humerus
- 90% of metastasis from epithelial tumors are found in red marrow.

3)Metastatic Foci:

- Grows in red marrow space.
- The surrounding bone remodels through osteoclastic (resorption) and osteoblastic (deposition) activity.
- The relative balance between resorption and deposition determine whether the lesion is hot (sclerotic) , cold (lytic) or mixed pattern.
- The tracer does not concentrate in the metastatic foci (cancerous tissue) but in the surrounding reactive bone

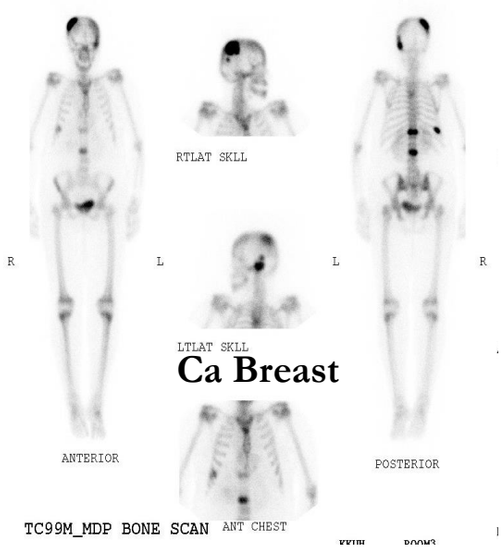
4)Scan Patterns:

- Solitary lesions.
- Multiple focal lesions.
- Diffuse involvement (Superscan).
- Photon deficient lesions (cold lesions).
- Flare phenomenon.
- Normal (false negative).
- Soft tissue lesions (tracer uptake in tumor).

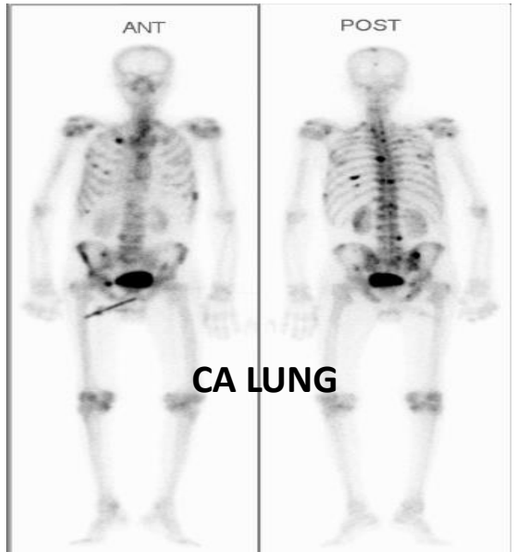
5)Sensitivity:

- In early stage superior to x-ray.
- In advanced stage both have high sensitivity.
- The accuracy of bone scan not known because of the lack of reference standard.
- The sensitivity is agreed to be 90% or more.

TUMOR STAGING



Ca Breast



CA LUNG

CA STOMACH

Bone scan is highly sensitive but not specific in detecting bone metastasis (Primary Cause)

Bone Scan In Metastatic Disease: Diffuse involvement(Superscan)

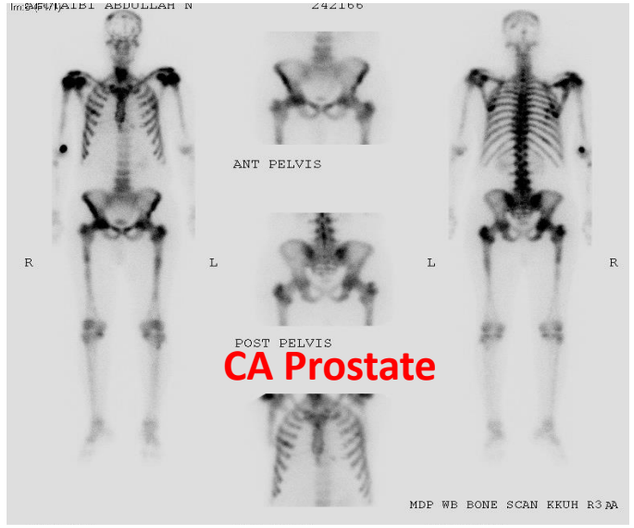
Definition : Bone scan with diffuse symmetrical increased uptake and almost absence of soft tissue activity, lack of kidney activity and bone uptake seen in blood pool images.

Causes :

1) Bone metastases : Prostate, breast, lung, bladder and lymphoma.
2) Non tumor causes (Metabolic bone disease): HPT (Hyperparathyroidism), osteomalacia, Pagets disease and fibrous dysplasia.

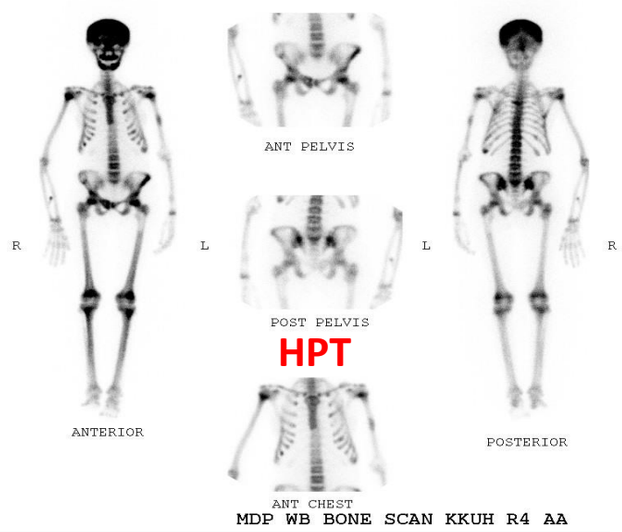
Important clues : In metabolic bone disease the calvarium and long bones are involved unlike in bone metastases.

Superscan



CA Prostate

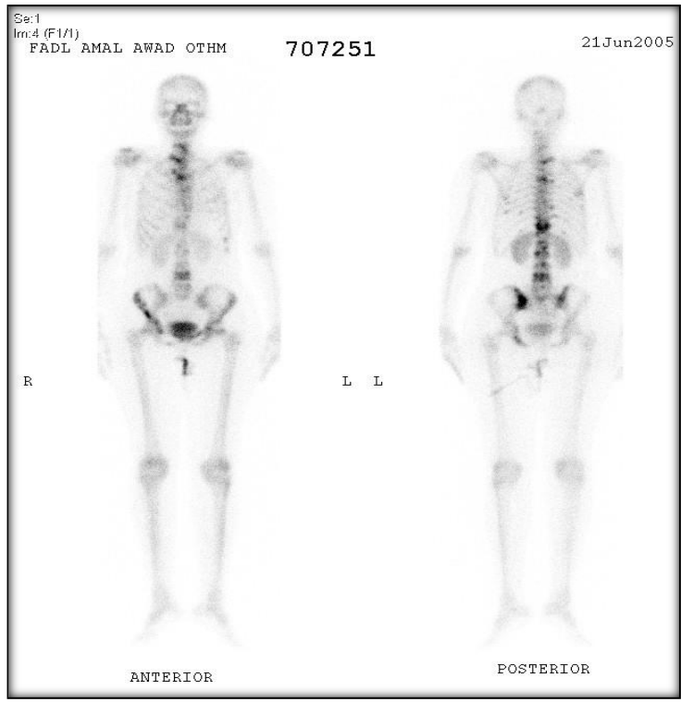
Bone metastasis is limit to axial skeleton (calvarium, spine , pelvis , proximal femurs and **proximal** humerus)

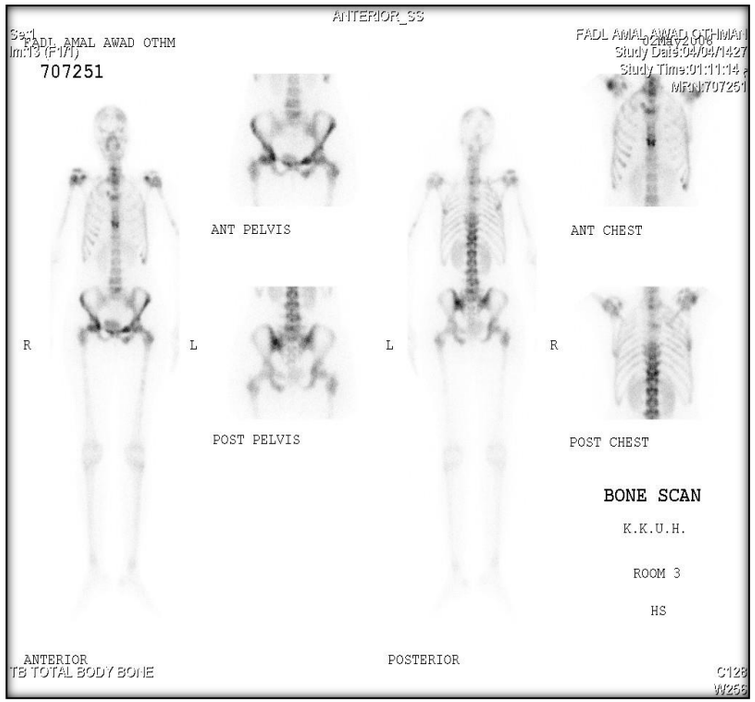


HPT

Metabolic bone disease is affecte whole skeleton

Bone Scan : Radiation Effects

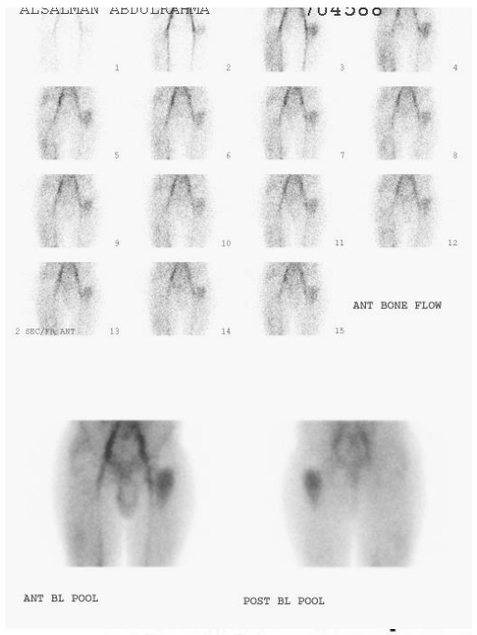


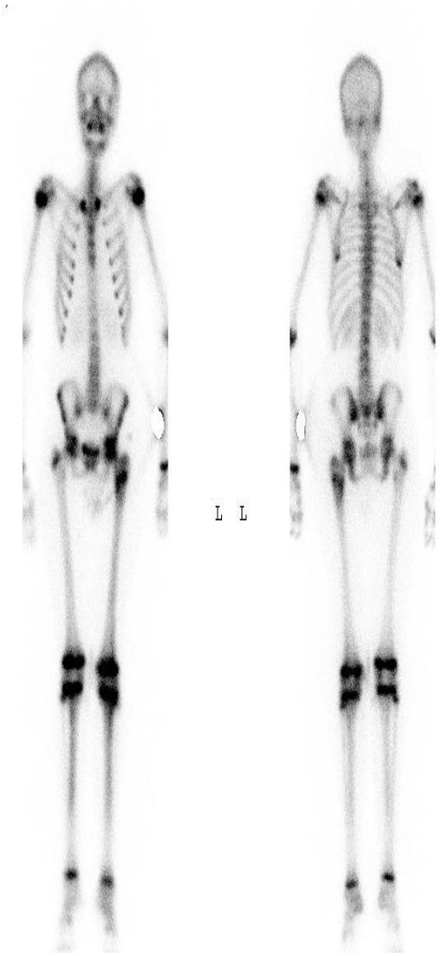


- Hours following radiation : Increased uptake due to increased blood flow and vascular permeability.
- 3-6 months post radiation : Decreased uptake due to microvascular injury. Dose related (>2000 rads).
- Following Radiotherapy : Spontaneous ribs fracture may occur.

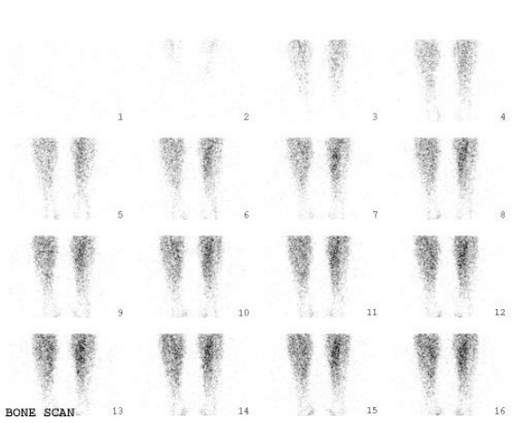
Pure Lytic Lesions (renal cell carcinoma)

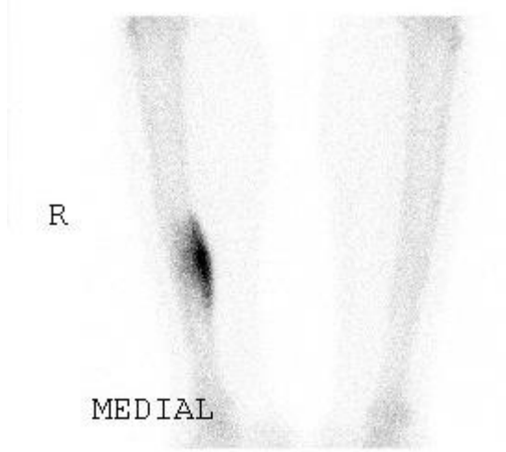
Ewing's Sarcoma

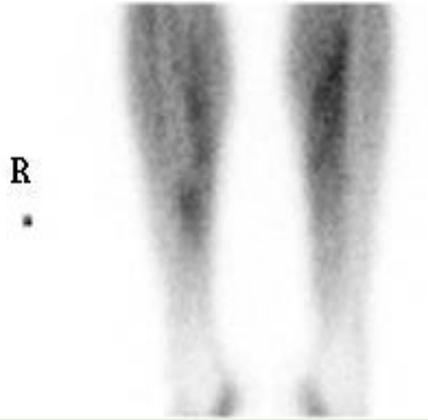


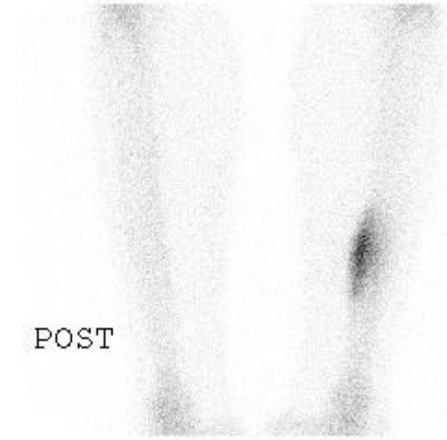


Bone Scan In Bone Tumors (Osteoid Osteoma)





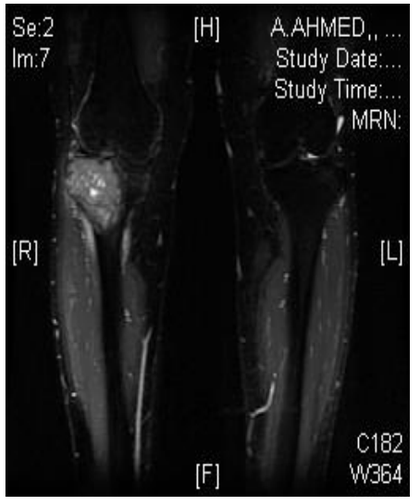


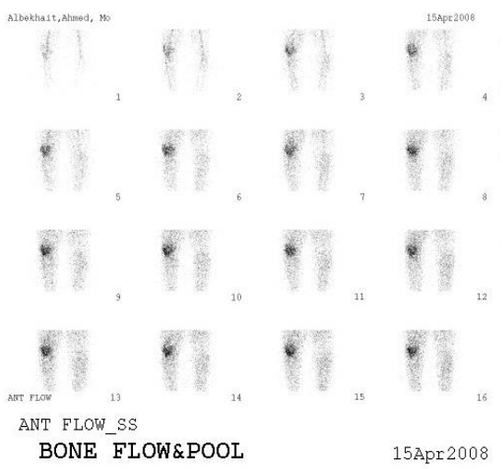


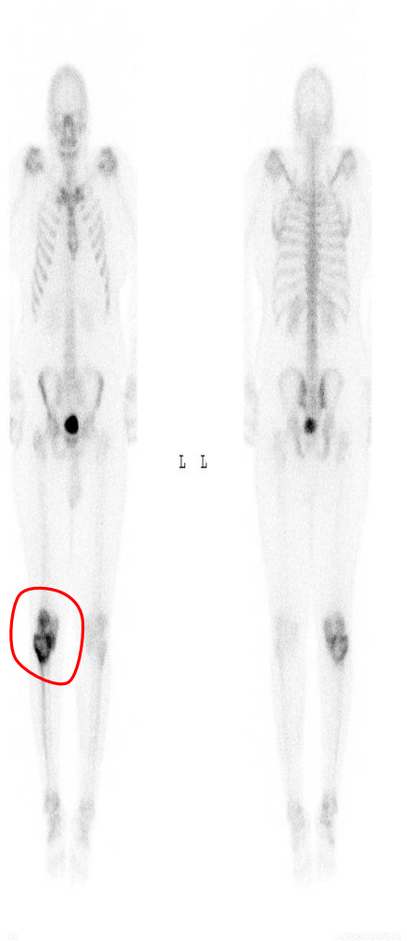
More common in pediatric : Primary benign bone tumor characterized by night pain that is relived by aspirin .

C128
W256

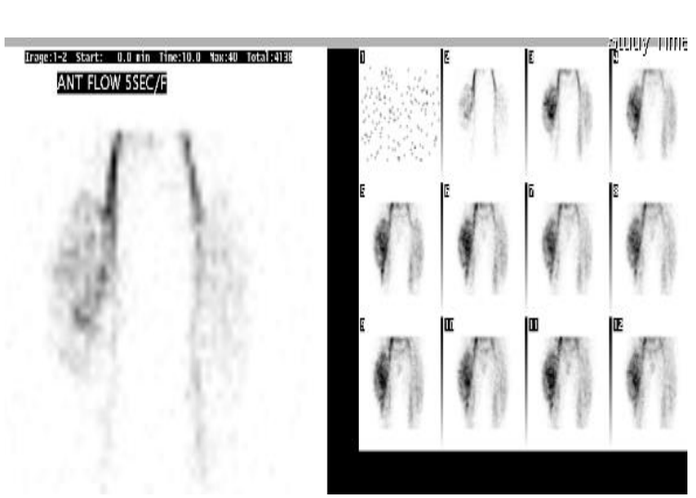
Giant Cell Tumor







Soft Tissue Sarcoma



Large soft tissue sarcoma in the right thigh with underlying erosion of bone but with no metastasis

Gallium 67 (Ga-67) scan SPECT agent

Properties: Introduced in seventies of 20th century for lymphomas

- Mechanisms of accumulation
  - –Tumour viability
  - –Blood flow
  - –Capillary permeability
  - –Lymphatic drainage
  - –Binds to Transferrin receptors on the tumour cells
- Non specific for infection-inflamation and tumors
- Excretion: Kidneys and large bowel

Imaging Protocol:

- Patient preparation : Laxatives for bowel preparation post injection, nothing else
- Several weeks post tumor therapy (FN)
  - Radiation therapy and chemotherapy can alter the normal pattern of gallium distribution
- 180 MBq (4-5 mCi) is usually administered
  - Imaging follows after 48 – 72 hours
  - WB + SPECT/SPECT CT, midium-energy collimator

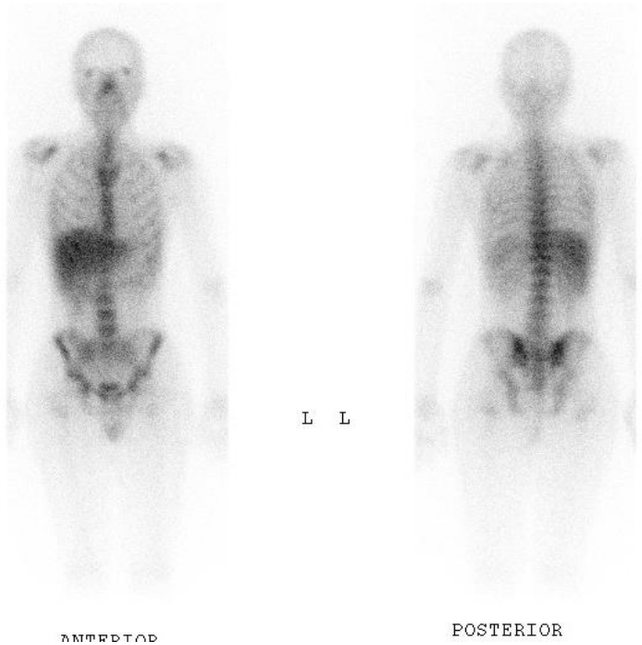
Normal distribution: Ga-67 scan

1) Normal scan

- Accumulates in bone marrow and liver.(if agent goes outside of these two locations is considered abnormal)
- Splenic uptake is variable.
- The kidneys are usually visualized and also lacrimal, salivary, nasopharyngeal and genital activity is often present.
- Female breasts can be visualized, but accumulation is physiologically symmetrical
- Radioactivity is commonly seen in the colon

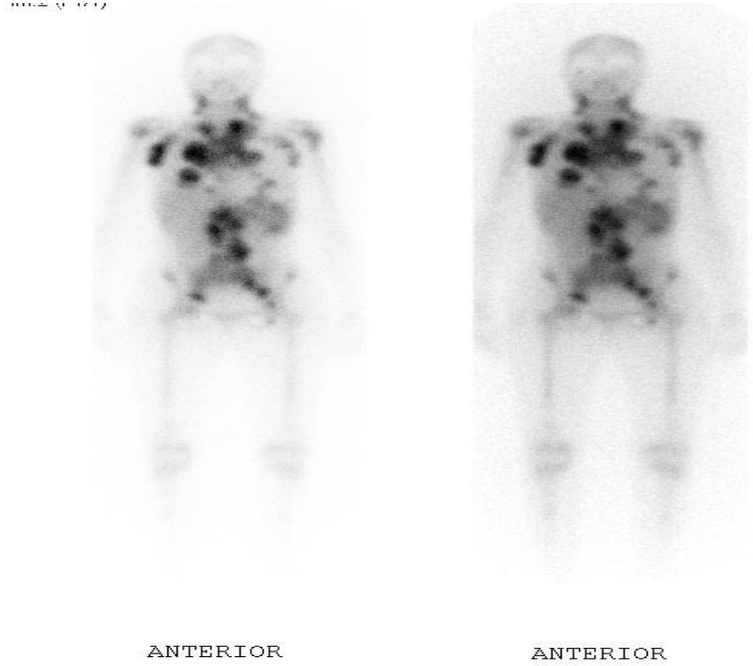
2)Clinical indications

- Lymphoma
- Melanoma
- Lung cancer
- Hepatoma



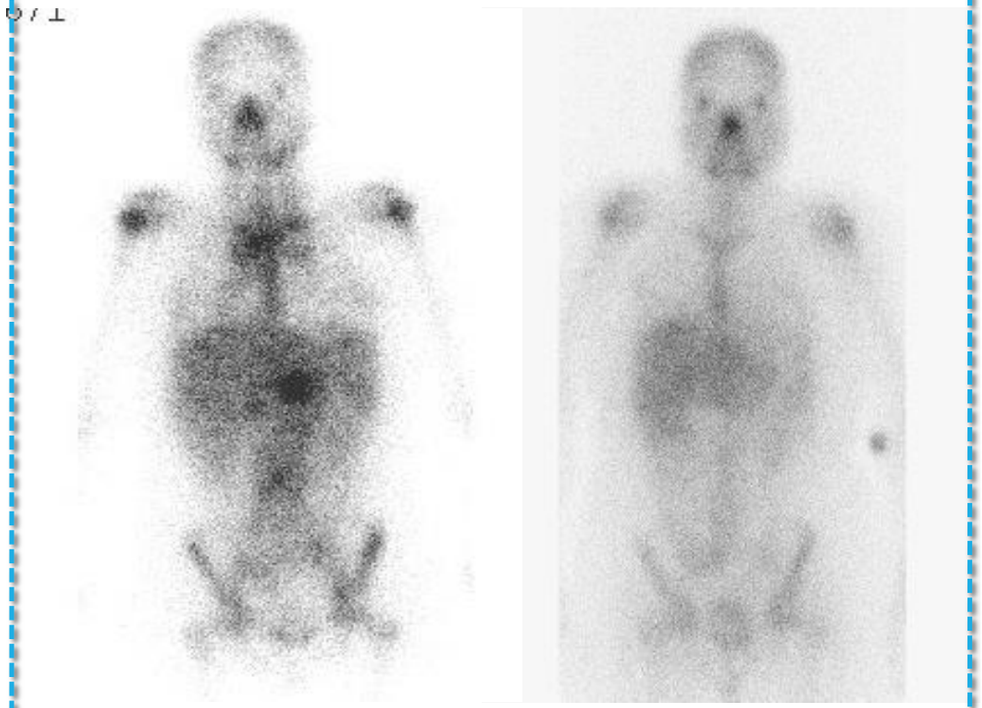
Gallium Scan in Lymphomas

- Staging
- Follow up and monitoring of therapy
- Detection of tumor recurrence
- Differentiate postherapy changes : tissue necrosis and fibrosis from local recurrence.



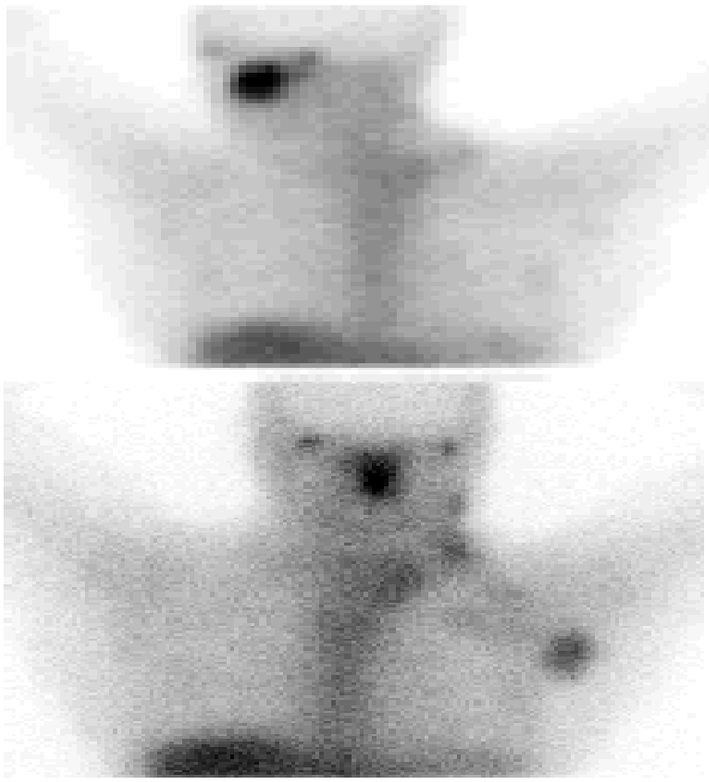
Ga-67 Scan In Lymphoma

Prediction of response to therapy



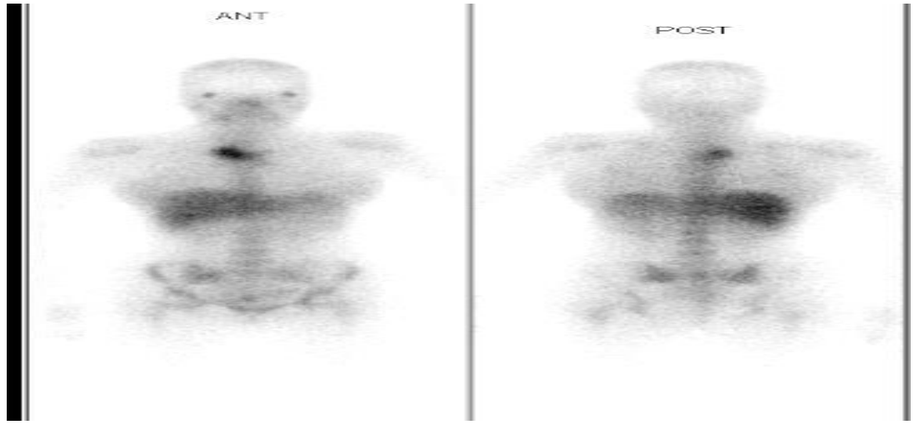
Normalization of a positive pre-therapy scan:
A negative scan after one cycle or at mid cycle is associated with a high likelihood of complete response .

Prediction of outcome

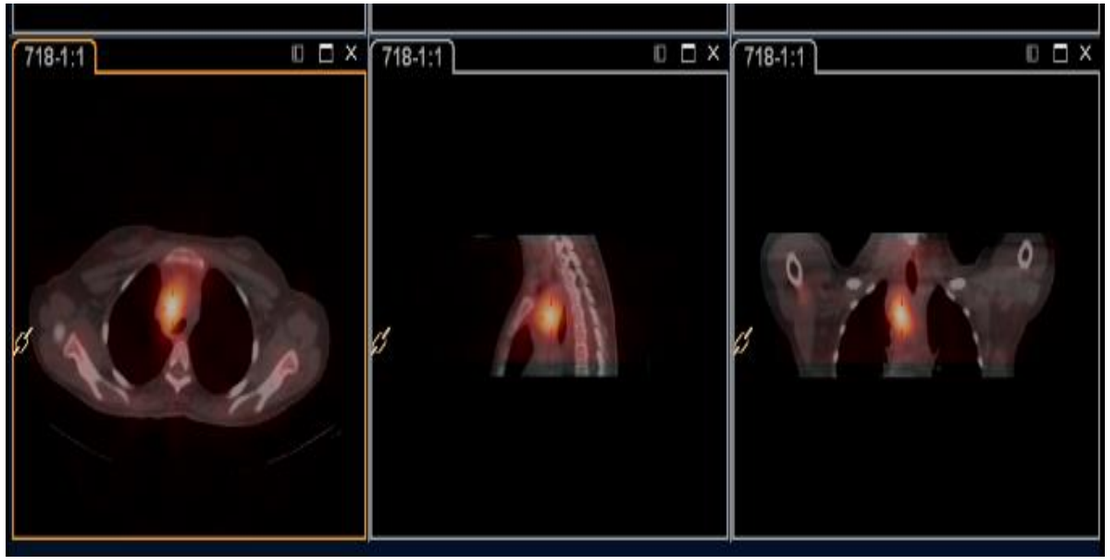


Residual gallium uptake after treatment is a poor prognostic sign,
indicates viable tumor and treatment should be modified.

Gallium Scan NHL



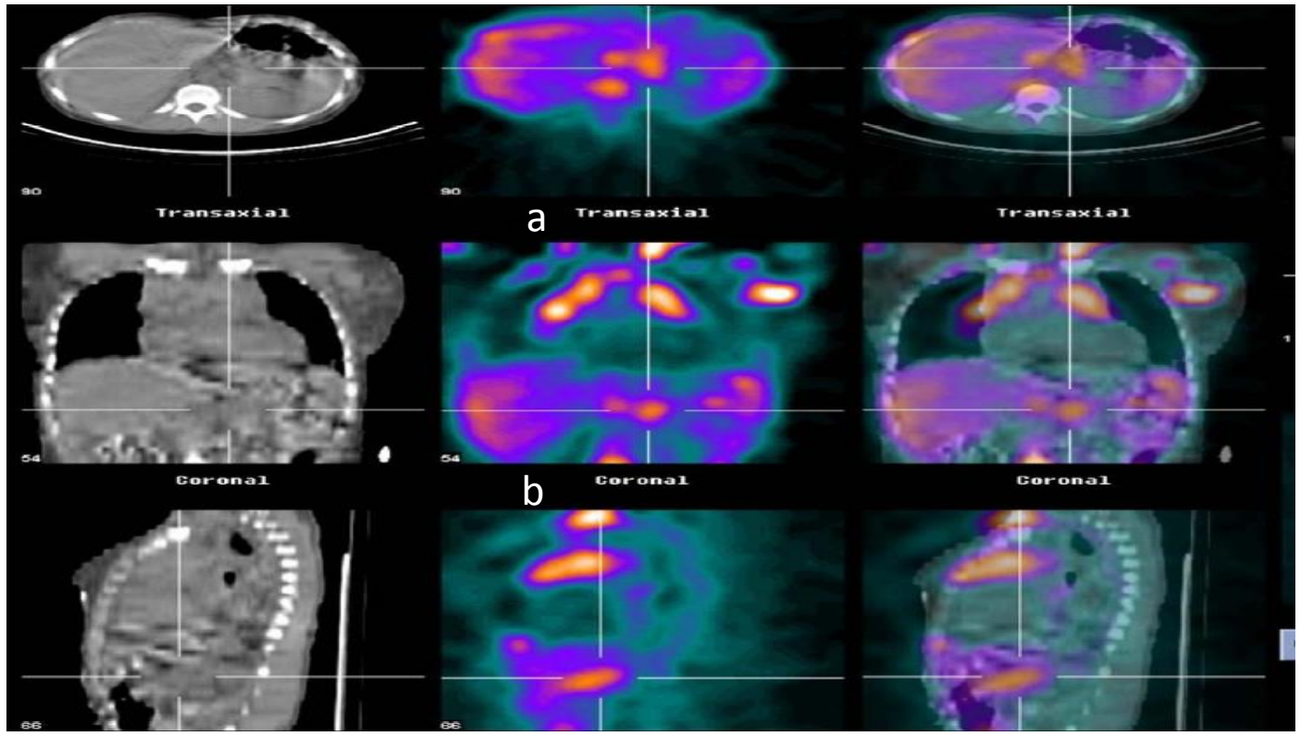
Planar Vs SPECT CT



Ga-67 SPECT/CT : Staging HD

Abnormal Ga uptake (a) in supraclavicular, axillary, Paratracheal , parahilar and para-aortic lymph nodes and in the spleen, at lesion sites corresponding to those observed on CT.

The para-aortic lymph node uptake (b) combined with CT findings allowed the diagnosis of subdiaphragmatic disease and excluding bowel activity.



Neuroendocrine Tumors

Indium-111 Octreoscan: Insulinoma

It is metabolized in the liver, concentrated in spleen and excreted by the kidneys.

Clinical History:

The patient is a 66-ys male with insulinoma, now being evaluated for evidence of recurrent and/or metastatic disease.

Findings :

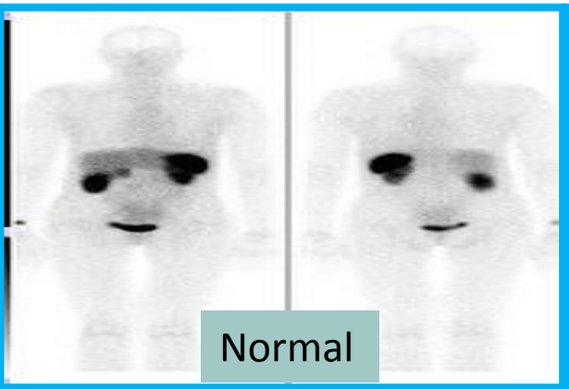
Multiple lung, mediastinum

123 MIBG Scan:MIBG : Meta Iodo Benzyl Guanidine

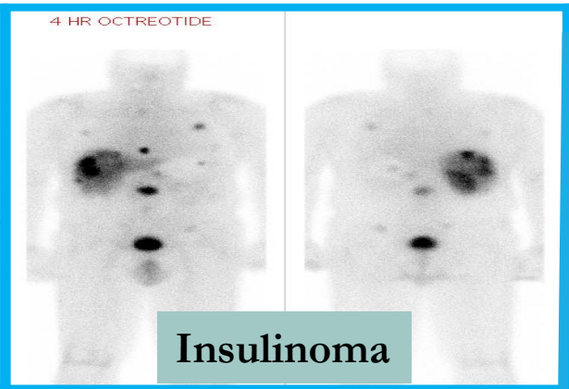
- Is a **nor adrenaline analog**
- **Localizes in adrenergic tissues:** catecholamines producing tumors and their metastases.
- **Patient preparation:** stop drugs interfering with MIBG uptake. Lugols solution to protect thyroid gland

I123 MIBG Scan Indications:

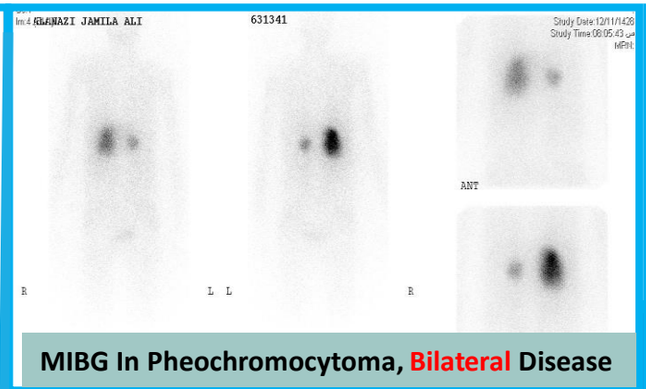
1. Pheochromocytoma
2. Paraganglioma
3. Insulinoma
4. Neuroblastoma
5. Medullary thyroid carcinoma
6. Carcinoid tumors



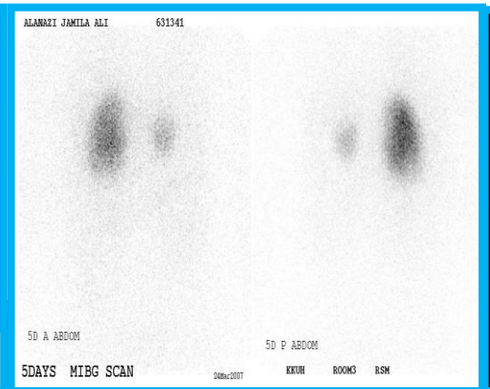
Normal



Insulinoma

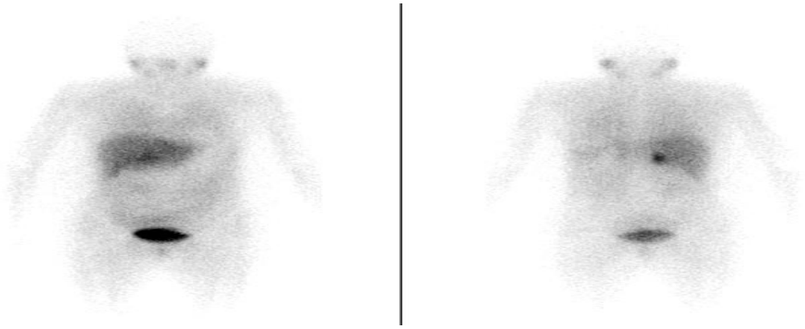


MIBG In Pheochromocytoma, Bilateral Disease

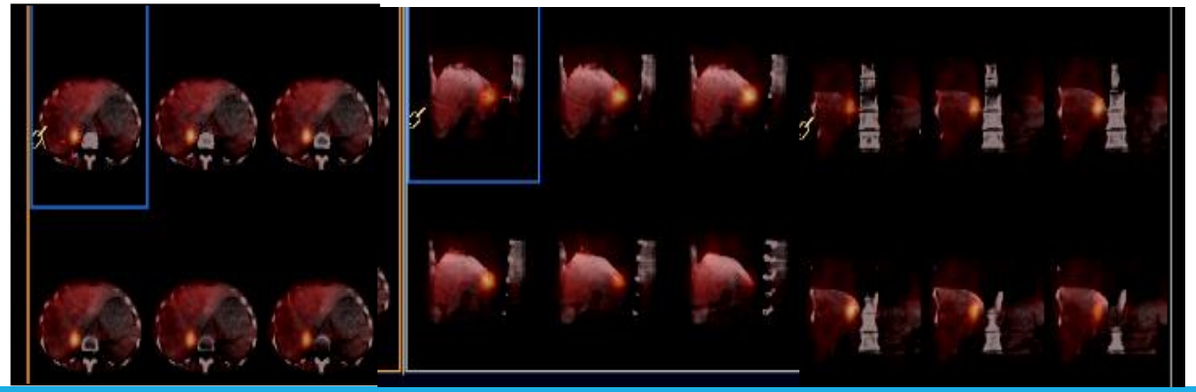


Pheochromocytoma

A 41 years old female patient is with 2ry hypertension. Right adrenal mass? Pheochromocytoma.
It show more localization and size in the right para-spinal area above the adrenal gland near the vertebra .

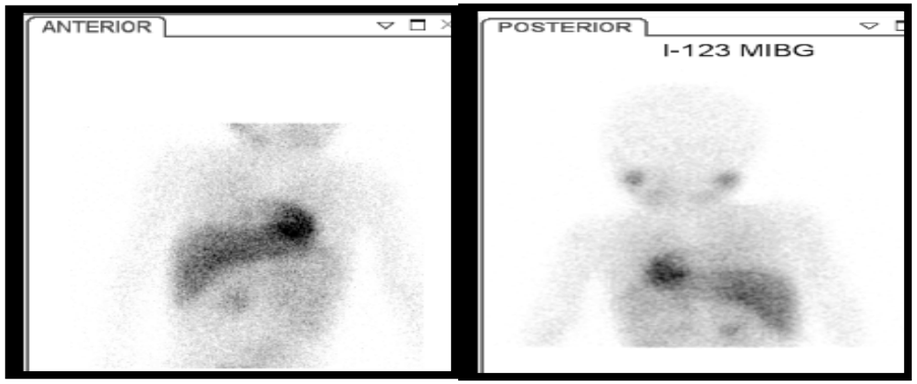


Planar Vs SPECT CT

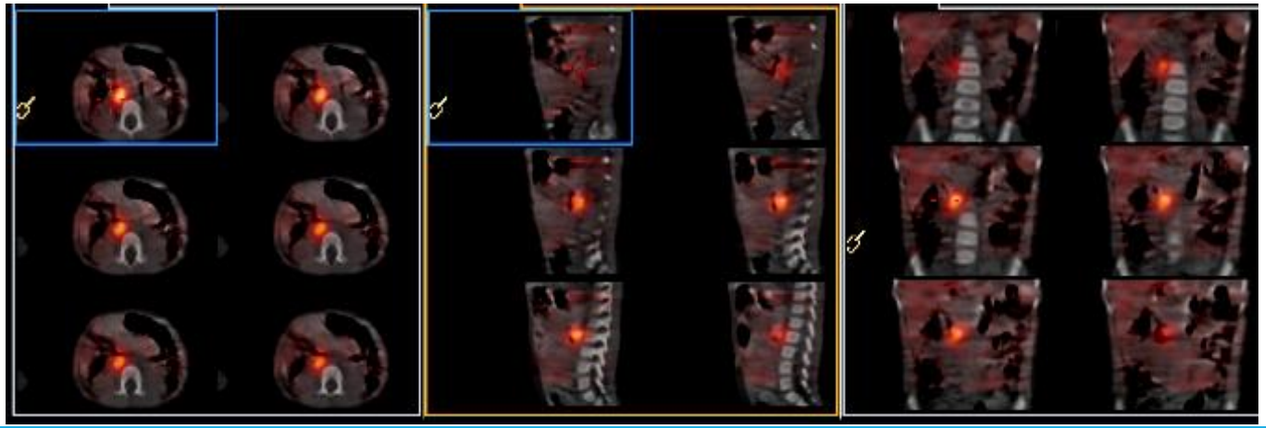


Neuroblasoma

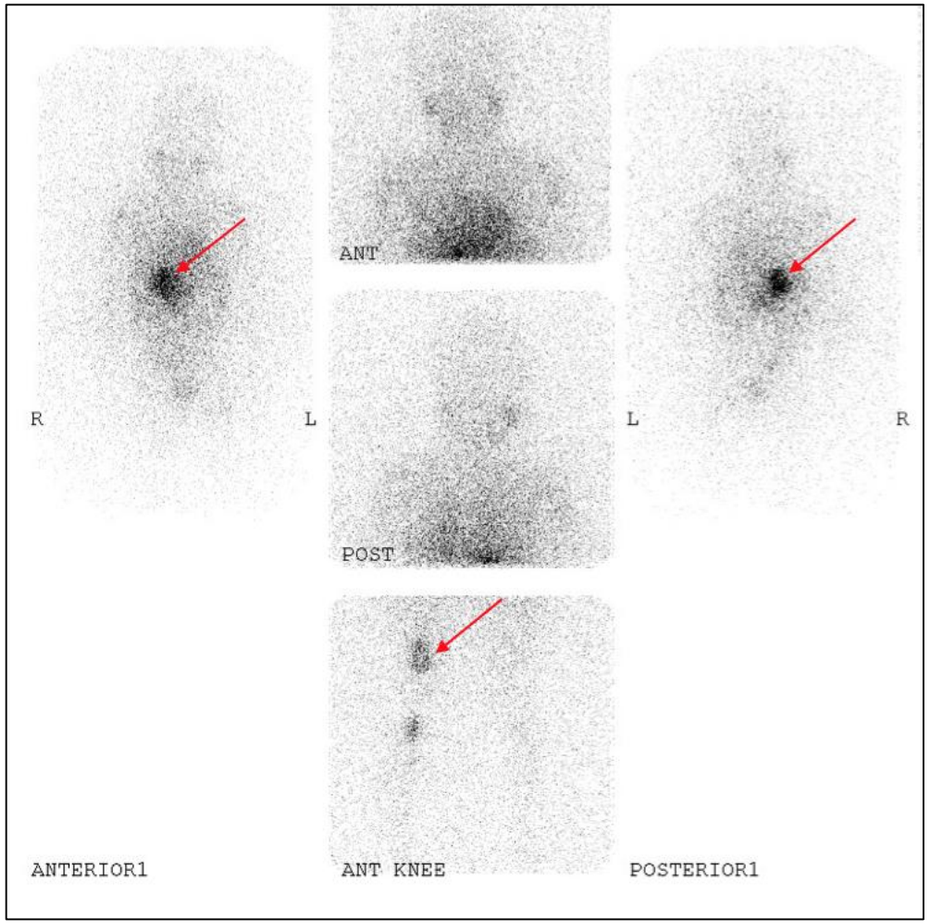
•It is a tumor that affects the children under 5-years. MIBG would tell if it is a primary and if there is a metastasis. This patient has no metastasis, only the primary mass in the abdomen anterior to the spine .

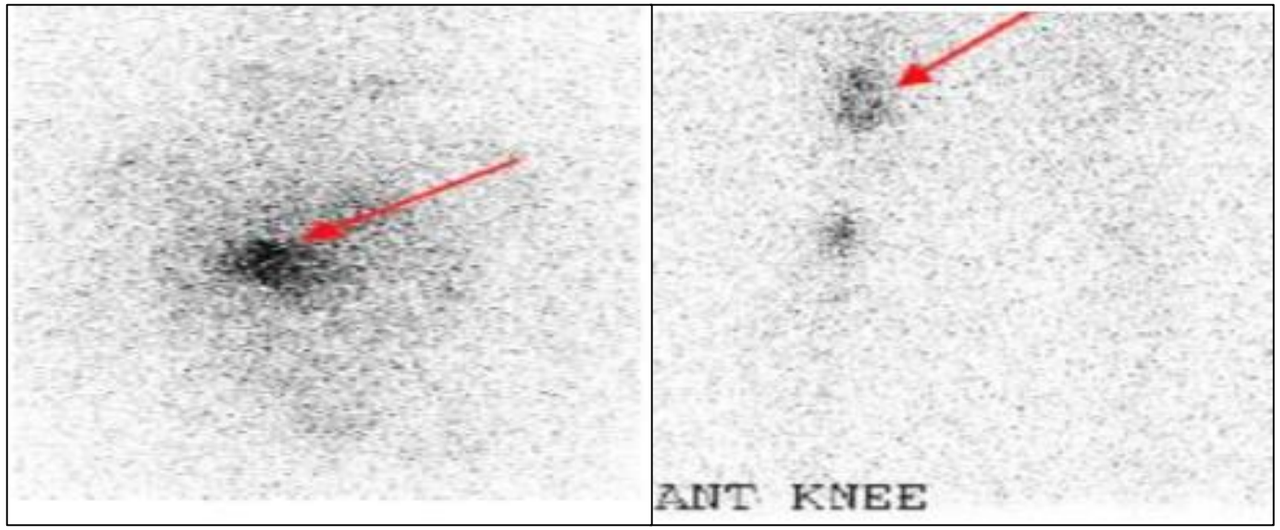


Planar Vs SPECT CT



1ry neuoroblastoma with bone metastasis (Treated with I131 MIBG)





How do you know it is a tibia? by correlating it with the X-ray >>
<< 1ry Abdominal mass

THYROID METASTASES STUDY

(I-123 or I-131 as Sodium Iodide) Diagnostic and therapeutic

Indications:
Detection and localization of persistent or recurrent local or distant functioning thyroid cancer

Patient Preparation:

- **Stimulation of potentially functioning thyroid tissue**:

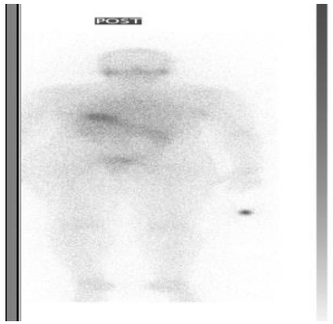
A. Inject recombinant human thyrotropin on 2 consecutive days and administer the iodine on the third day .
B. Withdraw thyroid replacement hormones :

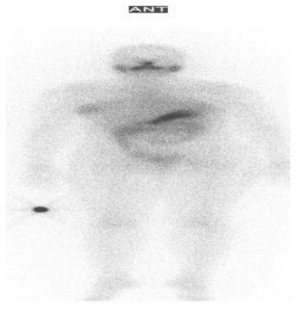
1. Thyroxine (T-4) for at least 4 weeks.
2. Triiodothyronine (T-3) for at least 10 days.

- **The patient must not have had i.v iodinated contrast material (IVP, CT with contrast, myelogram, angiogram) for at least 3 weeks .**
- **The patient should be NPO for at least 4 hours prior to radiopharmaceutical administration and for at least 1 hour afterwards**

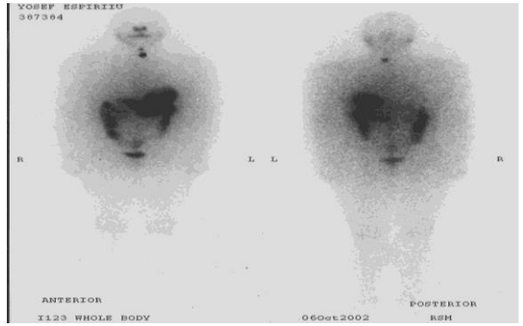
Tracer , Dose, & Technique of Administration:
Radiopharmaceutical: **Oral administration**
a. I-123 as sodium iodide : 2 mCi
b. I-131 as sodium iodide : 2-10 mCi
Imaging using Gamma camera:
Whole body scan

A: Thyroid Cancer I-123 WB Scan





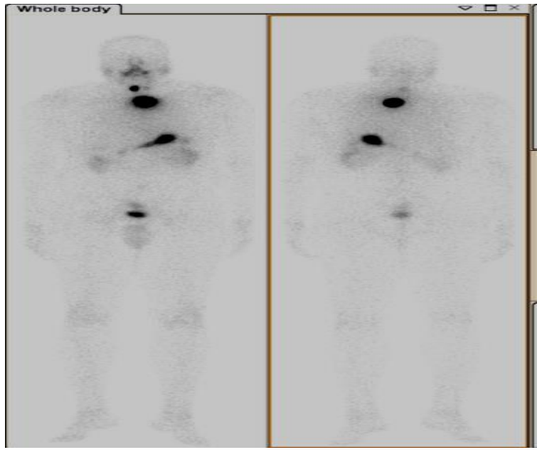
Negative I-123 WB Scan

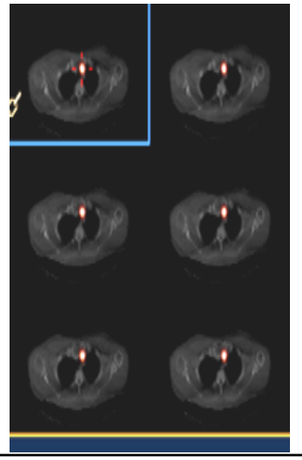


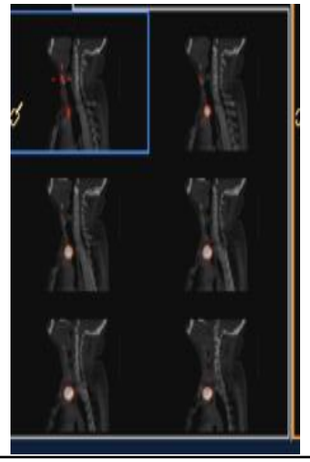
I-123 WB Scan : Post operative Thyroid remnants

B:I-123 WB Scan: Post operative Thyroid remnants

Planar Vs SPECT CT

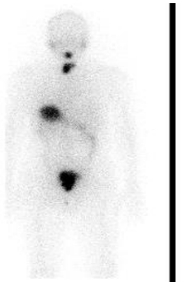




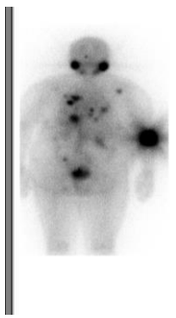


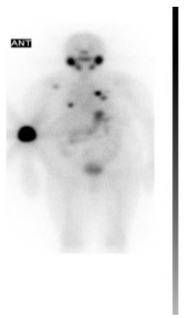
C: THYROID METASTASES STUDY: (I-123 or I-131 as Sodium Iodide)

I-123-scan: Patient with recurrent thyroid cancer and metastasis to the anterior mediastina "Planar Vs. SPECT CT"

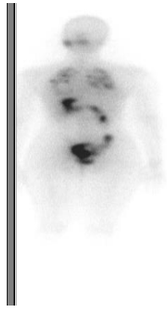


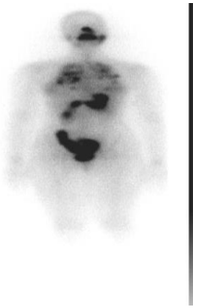
Local Recurrence





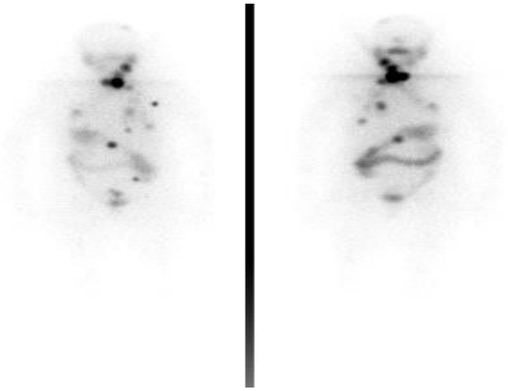
Bone Metastases



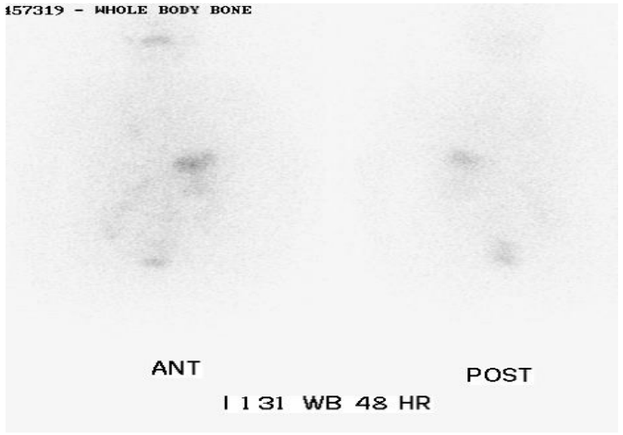


Lung Metastases

D: Thyroid Cancer: I-131 Pre & Post therapy



Dec04

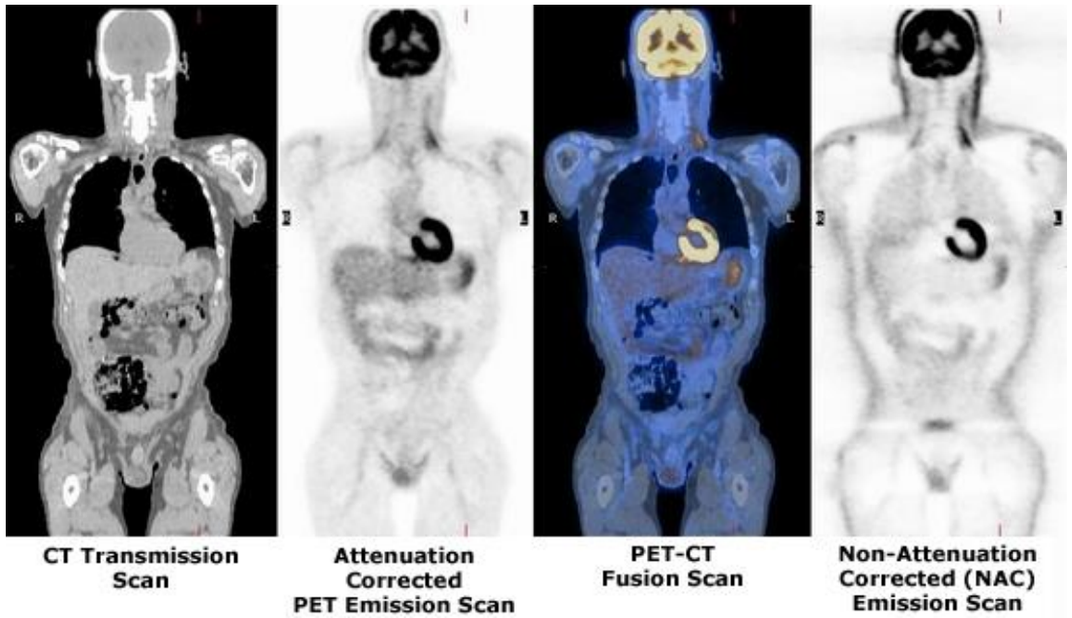


March06

Onco PET (PET and PET CT)

What is PET - CT ……?

- **PET : Positron Emission Tomography.**
- **CT : Computerized Tomography.**
- **PET-CT is the fusion of functional and anatomic information acquired almost simultaneously from which we are able to visualize form and function.**

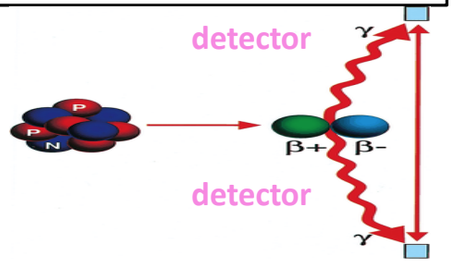


CT Transmission Scan | Attenuation Corrected PET Emission Scan | PET-CT Fusion Scan | Non-Attenuation Corrected (NAC) Emission Scan

PET CT = PET + CT = Function + Form

PET : How it is performed…?
Skipped by the Dr

Positron emitters (e.g. F18) labelled with biologically active natural compounds such as oxygen, carbon or glucose give intravenously and reacting in the body identically to their non-radioactive counterparts. Positrons are emitted from F18 and react with tissue electrons…..Inhalation occurs… Two photons 511 kev each in opposite direction are emitted and detected by PET SCANNER giving an image of the normal and abnormal distribution of tracer in the body.



Positron Emitting Isotopes

❑ **Cyclotron produced isotopes:**

Isotope	T/2
Oxygen-15	2 min
Nitrogen-13	10 min
Carbon-11	20 min
Fluorine-18	110 min

❑ **Generator produced isotopes:**

Parent	T/2	daughter	T/2
Strontium-82	25 days	Rubidium-82	75 seconds
Zin-62	9.3 hrs	Copper-62	10 min.
Germanium-68	288 days	Gallium-68	68 min

FDG : Fluoro-2-deoxy-D-Glucose (Uptake Mechanism)

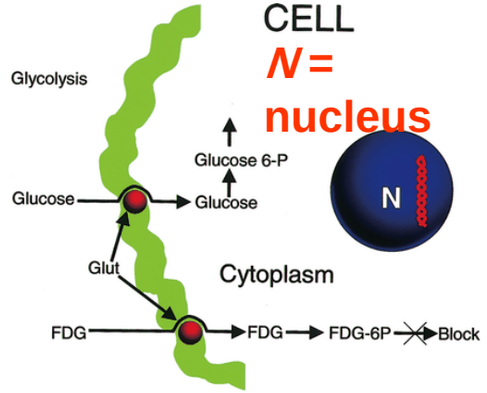
FDG is a glucose analogue used to asses glucose metabolism.

FDG transported from intravascular space to the cells by the same mechanism as the glucose.

In the cell, hexoKinase acts on both FDG and glucose to form:

- FDG-6-phosphatase (FDG-6-PO4-)
- Glucose-6-phosphatase.

FDG-6-PO4- cannot progress further into glucose metabolism and remains trapped intracellularly in proportion to glycolitic rate of the cell.



Normal distribution of FDG

- Brain & heart -High uptake
- Liver -Less uptake
- Kidneys -Unlike glucose, FDG is excreted with urine
- GI-Mild clearance, faintly seen ;
- Muscles- Low, increase with exercise

In tumors, there is high rate of glycolysis compared to normal cells as well as higher level of hexoKinase.

FDG is labeled with F18

FDG in Oncology

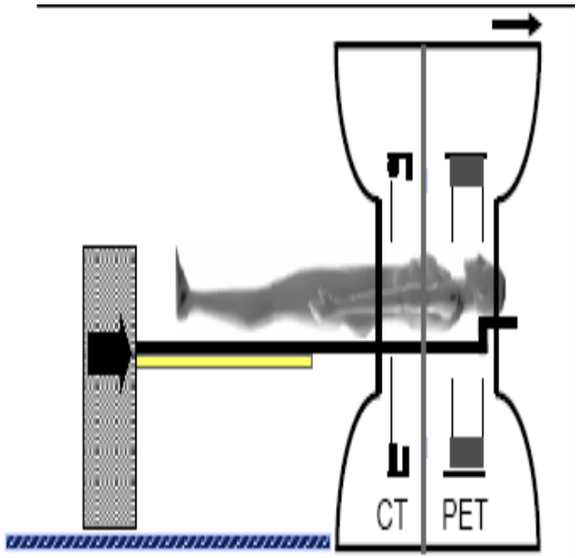
- Tumors do not have a blood tumor barrier
- FDG transport into tumors occurs at a *higher* rate than in the surrounding normal tissues.
- FDG is de-phosphorylated and can then leave the cell.
- The de-phosphorylation occurs at a *slower* rate in tumors.

Applications of FDG

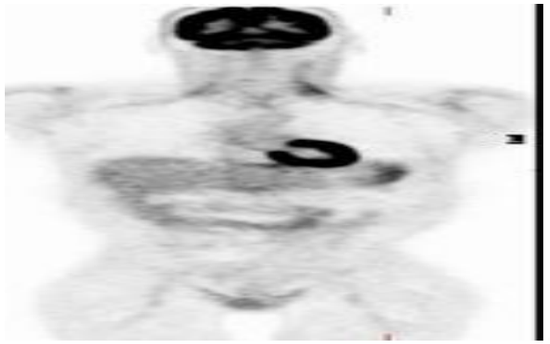
- Locating unknown primaries
- Differentiation of tumor from normal tissue
- Pre-operative staging of disease (lung, breast, colorectal, melanoma, H&N, pancreas)
- Recurrence vs necrosis
- Recurrence vs post-operative changes (limitations with FDG)
- Monitoring response to therapy

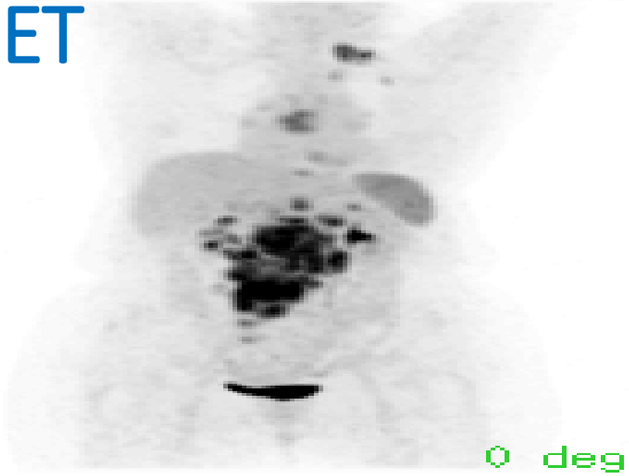
PET CT : F18 FDG IMAGING PROTOCOL

- ❖Fasting : 4 – 6 hours (To prevent heart uptake)
- ❖Dose : Inject 10 mCi F18 FDG
- ❖Wait (uptake phase): 45 -60 min then scan
- ❖Scanning time : 30 min to complete PET CT study
- ❖SUV : Standard uptake value (N:0.5-2.5 and Tumors > 3.0)



FDG PET



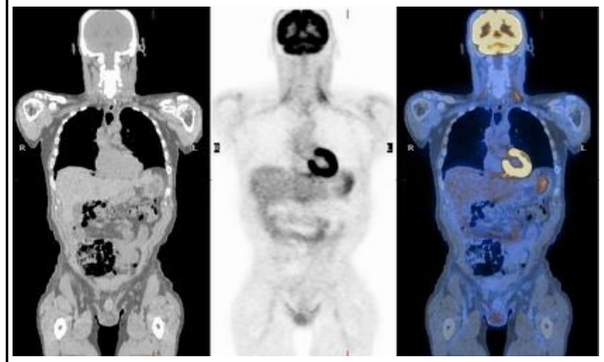


FDG PET : Normal

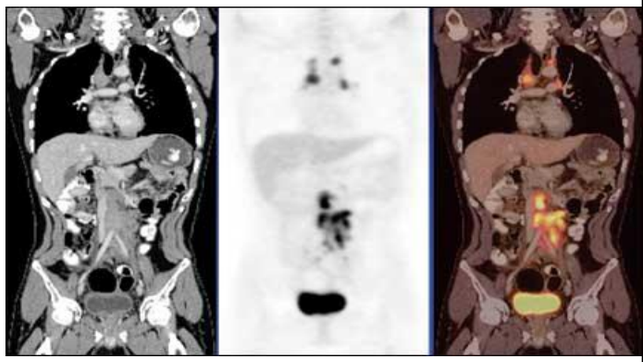
FDG PET : Staging of NHL

FDG PET-CT

Brain has high metabolic rate so it's normally black and so, the PET has low sensitivity for brain tumors



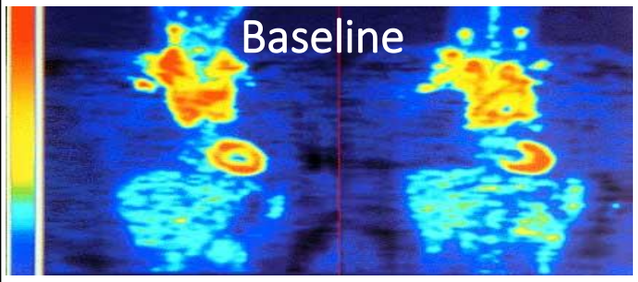
>FDG PET-CT : Normal

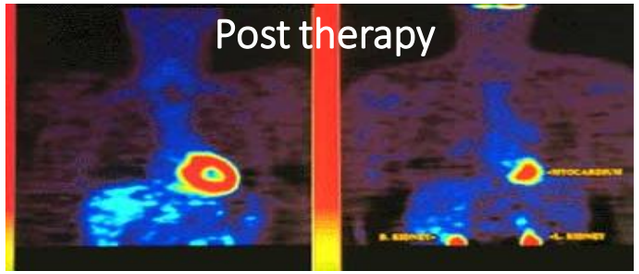


FDG PET-CT: Staging NHL< lymph nodes in mediastina and abdomen

Assessment of therapy response

FDG PET in HD Very good response!

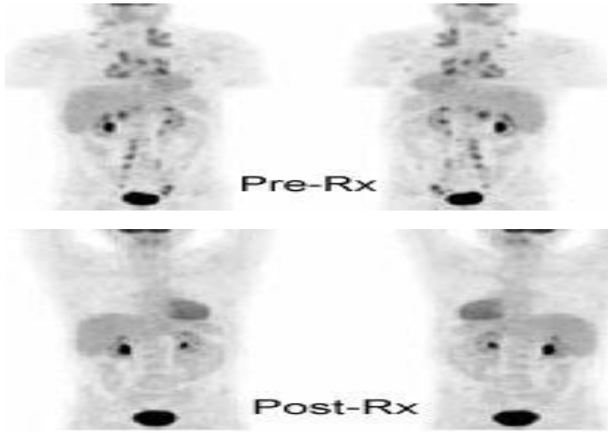




A 22 years old male patient with Hodgkin's lymphoma. Six months after chemotherapy, CT scan showed bilateral hilar abnormalities. FDG-PET scan did not show any activity in described CT changes.

FDG in Non-Hodgkin's lymphoma

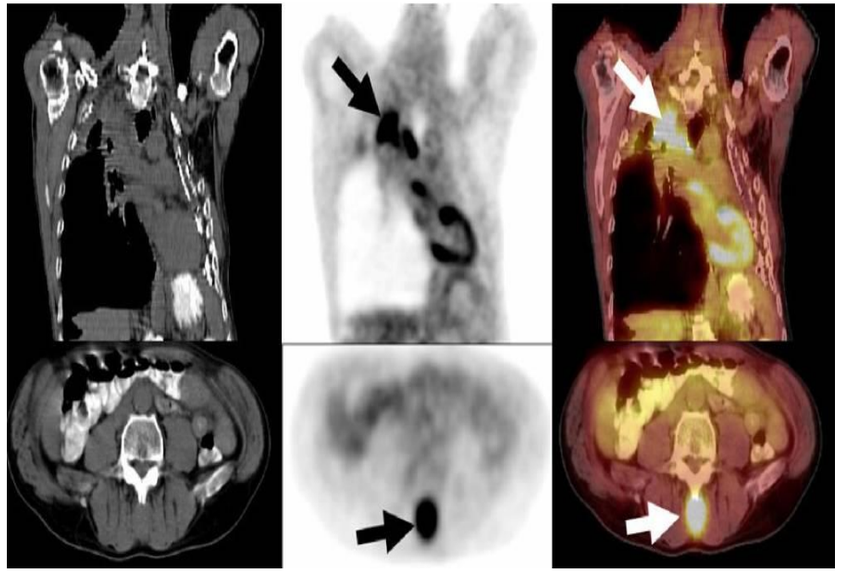
Response to therapy



PET CT In Lymphoma

	Sensitivity (%)	Specificity (%)
CT	61	89
FDG-PET	78	98
FDG-PET and CT	91	99
FDG-PET/CT	96	99

PET CT Lung Cancer (Staging)



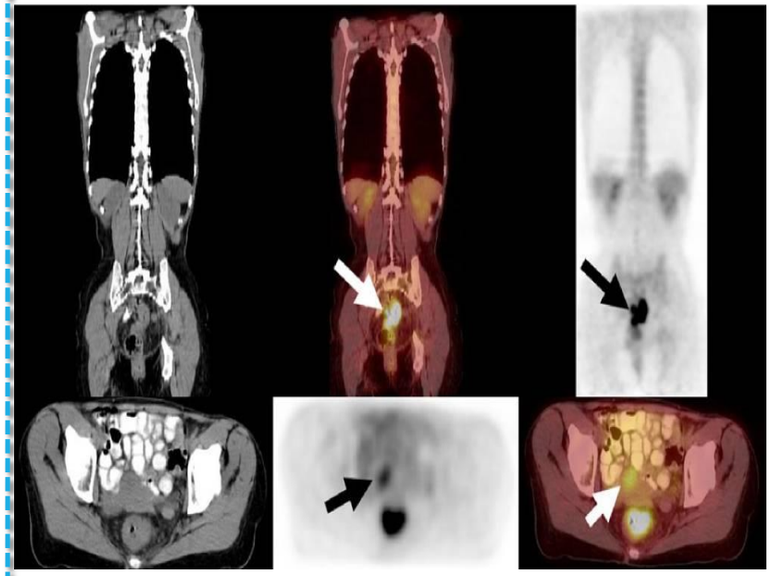
FDG avid soft tissue mass associated with a destructive L5 spinous process consistent with metastatic deposit (arrow).

FDG PET CT in Solitary Pulmonary Nodule (SPN)

Sensitivity : 82 – 100 %

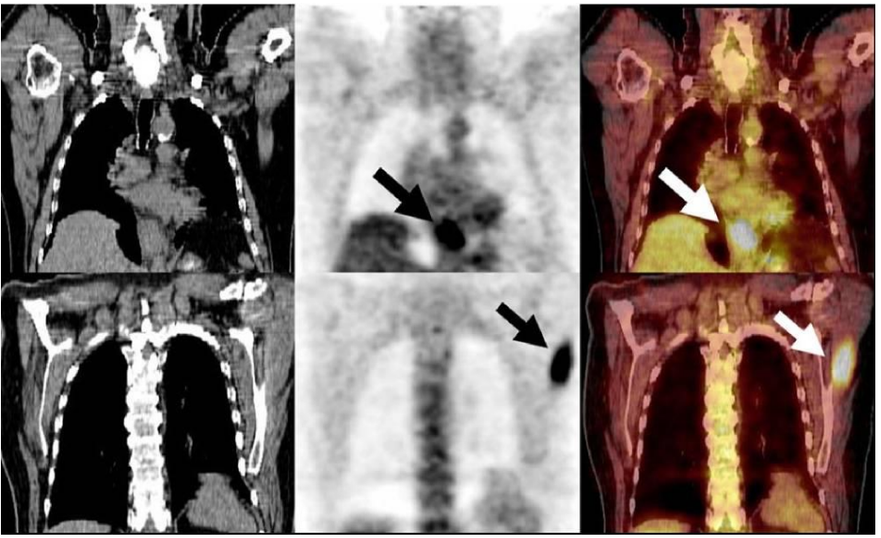
Specificity : 67 – 100 %

CA Rectum : Staging



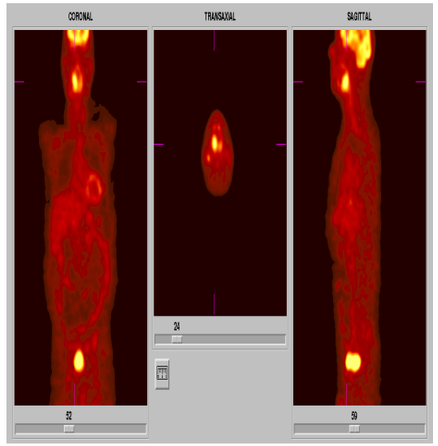
A 57-year-old woman presented with pain and constipation and colonoscopy revealed an obstructing rectal mass. A staging FDG-PET/CT demonstrated intense FDG avidity in a circumscribed mass-like thickening of the proximal rectum (arrows in top row images) and a focus of mild metabolic activity anterior to the rectum (bottom row arrow) which was not avid as the rectal malignancy. This was located within the uterus as seen on CT images (bottom row), and was subsequently shown to be a uterine fibroid on other imaging studies.

CA Esophagus: Staging

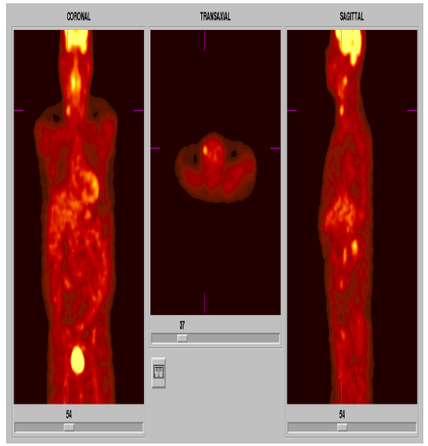


Based on FDG-PET/CT results the clinical management of this patient was changed from surgical resection of the primary tumor to combined chemo-radiation therapy. (Axillary lymph nodes met)

FDG PET: Tumor of unknown origin



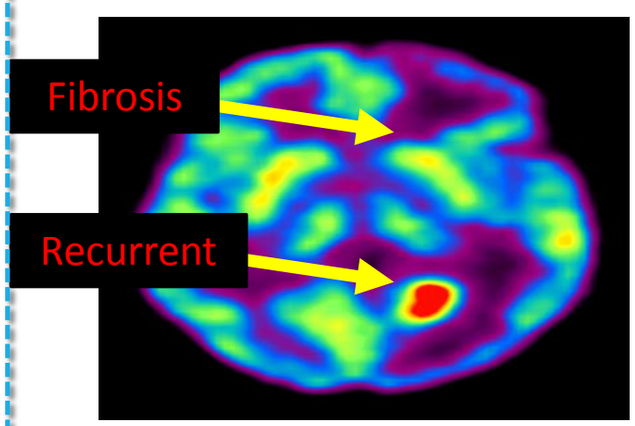
Pharyngeal cancer

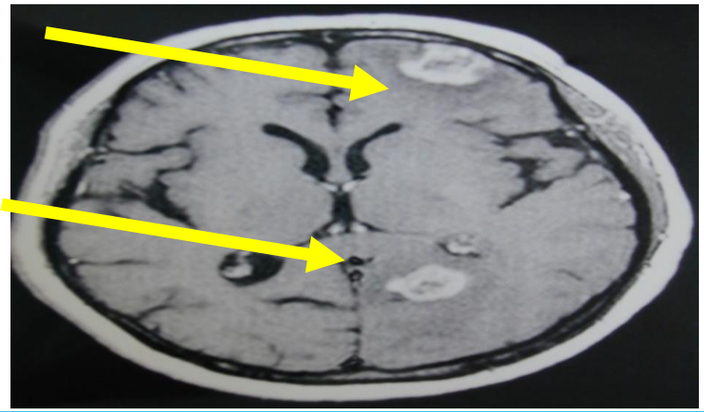


Metastatic involvment of neck lymph nodes

FDG PET

brain tumor post therapy Two foci on CT, only one viable tumor





Indications of PET CT

Breast Cancer*	Staging*, restaging*, and monitoring response to therapy*
Colorectal Cancer	Diagnosis*, staging* and restaging*
Esophageal Cancer	Diagnosis*, staging* and restaging*
Head & Neck Cancers (excluding CNS and thyroid)	Diagnosis*, staging* and restaging*
Lung Cancer (Non-Small Cell)	Diagnosis*, staging* and restaging*
Lymphoma	Diagnosis*, staging* and restaging*
Melanoma (Excludes evaluation of regional nodes)	Diagnosis*, staging* and restaging*
Solitary Pulmonary Nodule	Characterization of indeterminate single pulmonary nodule
Thyroid Cancer*	Restaging
Cervical Cancer*	Staging as an adjunct to conventional imaging

Somatostatin receptor PET tracers : Ga-68 DOTANOC

Radiopharmaceutical: DOTANOC , DOTATOC or DOTATATE is labeled with Ga-68

Dose:
3-5 mCi given intravenously.

PET Imaging time:
45-60 min postinjection

Clinical value:
higher lesion detection rate than is achieved with (18)F-fluorodihydroxyphenyl-l-alanine PET, somatostatin receptor SPECT, CT, or MR imaging.

Sensitivity:
70-100% (depends on density of somatostatin receptors in the tumor)

Indications:
Tumours with high expression of receptors of somatostatin

1. Gastroenteropancreatic tumours (e.g. carcinoids,gastrinoma, insulinoma, glucagonoma, VIPoma, etc.),
2. Sympathoadrenal system tumours (phaeochromocytoma, paraganglioma, neuroblastoma, ganglioneuroma)
3. Medullary thyroid carcinoma
4. Pituitary adenoma
5. Medulloblastoma
6. Merkel cell carcinoma
7. Small-cell lung cancer (mainly primary tumours)
8. Meningioma

Normal Distribution: 68Ga-DOTA peptide PET/CT

Normal tracer uptake is seen in the pituitary, salivary glands, thyroid, liver, spleen, adrenals, pancreas, kidneys, ureters, and bladder

Ga-68 DOTANOC PET

Metastasis from neuroendocrine tumor

NET with multiple metastatic disease confined to the liver and abdominal cavity

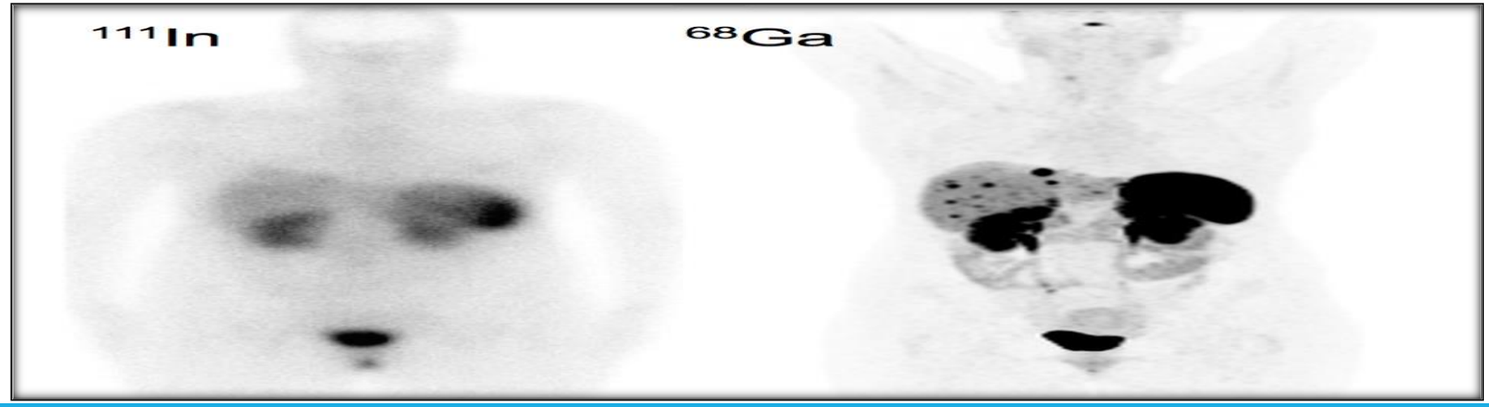
NET with extensive metastatic lesions throughout the body

Ga-68 DOTANOC PET superior to In- 111 Octreoscan

Carcinoid tumor :
Positive 68Ga-DOTA-NOC and Negative 111In-Octreoscan.

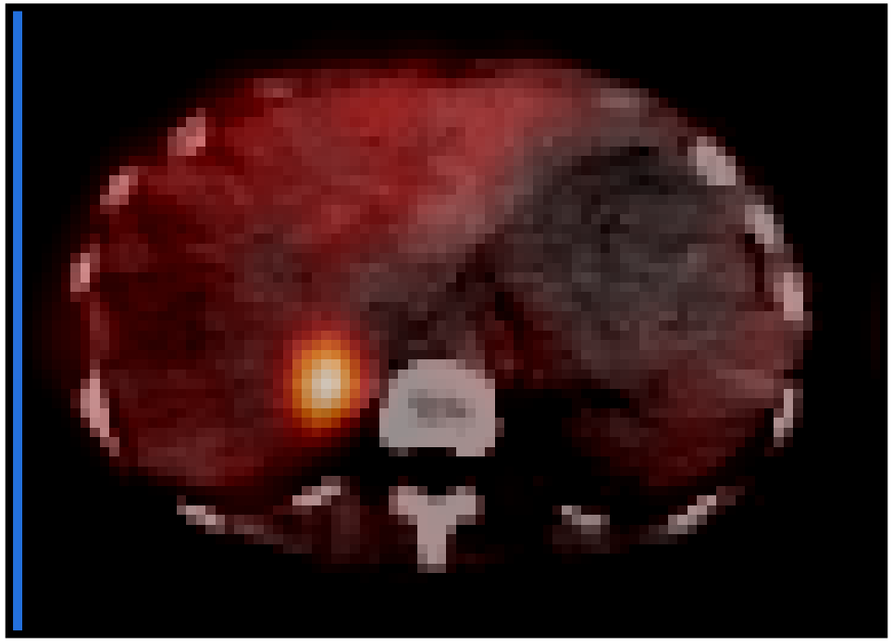
^{68}Ga DOTA-NOC Findings:
Multiple metastatic lesions in the liver. (The pituitary also expresses somatostatin receptors and is visualized in the 68Ga PET image, along with normal uptake in the spleen, kidneys, and bladder.)

Indication of ^{68}Ga DOTA-NOC:
The 68Ga PET scan was performed because the patient's symptoms were inconsistent with the 111In-Octreoscan findings.

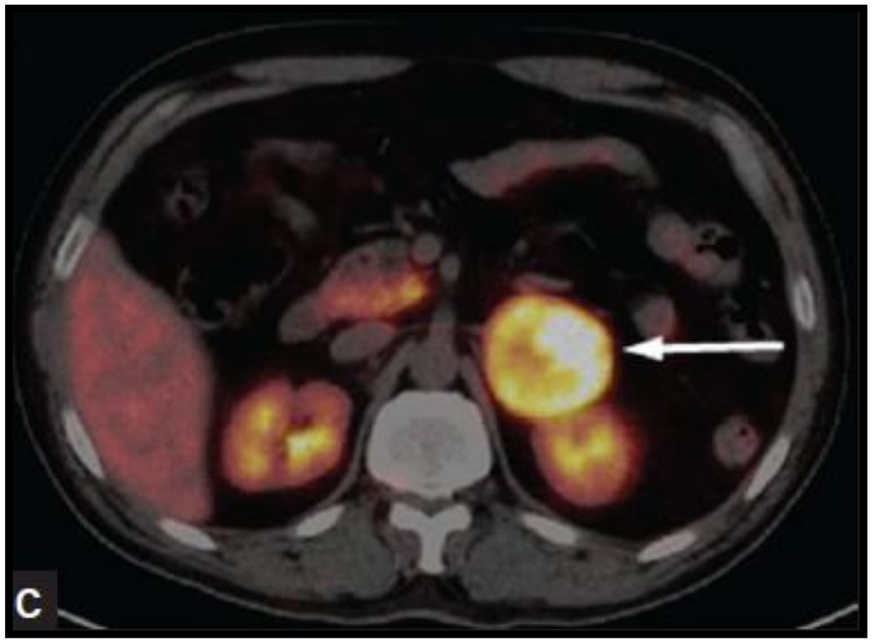


Pheochromocytoma

Ga68 DOTANOC superior to MIBG



SPECT CT - I123 MIBG



PET CT Ga68 DOTANOC

Radionuclide Therapy

Properties of the Ideal Therapeutic Radiopharmaceutical :

1. **Pure beta minus emitter** (so radiation is limited to that organ)
2. Medium/high energy (>1 meV).
3. Effective half-life = moderately long, e.g., days.
4. **High target:nontarget ratio** (To not damage other organs)
5. Minimal radiation dose to patient and Nuclear Medicine personnel
6. Patient Safety
7. Inexpensive, readily available radiopharmaceutical.
8. Simple preparation and quality control if manufactured in house.

Agent	Indication	Dose
I131 :	Thyroid cancer	100-200 mci
131 MIBG :	Neuroblastoma	100-300 mCi
Strontium-89 :	Bone metastasis	40-60uCi/kg
Sm-153-EDTMP:	Bone metastasis	1.0 mCi per kg
Phosphorus- 32 :	Polycythaemia	2.3 mCi/m2
Y-90-Ibritumomab Tiuxetan [Zevalin®]:	B-Cell NHL	0.3 mCi/kg

> Platelet count > 150,000 cells/mL: 0.4 mCi/kg
> Platelet count 100,000-150,000 cells/mL:
The dose should never exceed 32 mCi (1,184 MBq)

Strontium-89 Therapy for Palliation of Bony Metastases

History :

A 65 Ys ,M, with CA prostate and **widespread bone metastases and severe bony pain.**

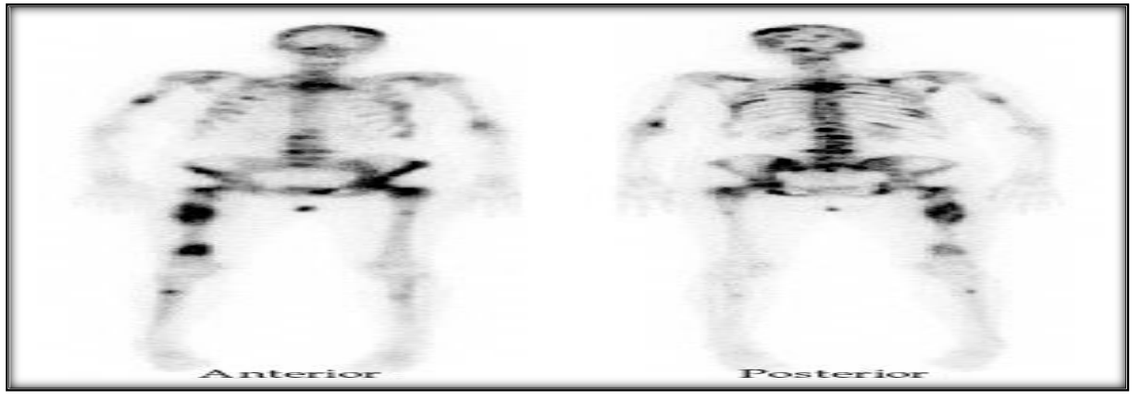
Admitted for palliative **Strontium-89 therapy.**

Procedure :

•Bone metastases was confirmed by bone scan.

•The patient was given 40 mCi of Strontium-89 I.V.according to body weight of the patient.

•The patient experienced one day of exacerpated pain which was controlled by opiates but the following day showed **gradual pain relieve.**



Teaching Points

NM tumor imaging

- **Functional**
- **Sensitive**
- **Whole body evaluation**
- **Specific : Some tumors**
- **Targeted therapy**

Objectives of NM tumor imaging

- **Diagnosis**
- **Staging**
- **Guiding biopsy**
- **Follow up and therapy monitoring**
- **Detection of recurrence.**

Thank You!

We hope you found this helpful and informative.

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