Radiology Team 429

Thyroid and Parathyroid Scans Basic Principles and Clinical Applications

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Radiology Team 429

In this team we used the outlines from the:

Doctor's slides

Lecture notes are in red boxes

427 Radiology team

Diagnostic Imaging –PETER ARMSTRONG – 6Th Edition

Sorry we don't hold responsibility for any missing information or perhaps – perhaps -wrong material.

We tried our best to present this lecture in the best way, and we hope what we wrote is enough to cover the subjects.

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Best Wishes :)

Thyroid Scan
LEARNING OBJECTIVES

At the end of the lecture you will be able to answer the following questions:

- How is the thyroid scan performed?
- When is thyroid scanning helpful?
- What is significant about whether a nodule is "hot" or "cold?“
- What is the role of nuclear medicine in the treatment of thyroid disorders?

Thyroid Scan

PROCEDURE

THYROID UPTAKE MEASUREMENT

How is the thyroid scan performed?

- Thyroid metabolizes the iodine. So, if a patient is given a radioactive iodine it will be concentrated in the thyroid. (Visualized by gamma camera).

How is the thyroid scan performed?
Thyroid Scan : Procedure

Patient Preparation:

- The patient must be off thyroid hormones :
  1. Thyroxine (T-4) for at least 3-4 weeks.
  2. Triiodothyronine (T-3) for at least 10 days.
- The patient must not be taking antithyroid medications:
  - Propylthiouracil (PTU) and tapazole for at least 3-5 days
- The patient must not i.v iodinated contrast agents (IVP, CT with contrast, myelogram, angiogram) for at least 3 weeks.

Radiopharmaceutical and dose:

- Tc-99m as sodium pertechnetate 0.5 -4.0 mCi given Intravenously. OR
- I-123 Sodium Iodide 0.5 mCi orally

Gamma camera: Small or large field of view.

Patient position: Supine with chin tilted up.

Imaging:

- 20 minutes post injection of Tc99 m : ANT, LAO and RAO images obtained.
- 6 and 24 hours post oral dose for I123 : ANT, LAO and RAO images .

How is the thyroid scan performed?
Thyroid Scan : Procedure

	Tc-99m Pertechnetate	I-123
Dose Half Life Cost	0.5-4.0 mCi given IV 6 Hours Not Expensive (Generator)	0.5 mCi orally 13 Hours Expensive (Cyclotrone)
Time of imaging	20 min post injection	6 and 24 hours post ingestion
Remarks	Trapped not organified	Trapped and organified

- I 123 used for imaging only pure gamma emitting, replaced by tc-99m which is easier and less radiation
- I 131 emits gamma and beta radiation, used for therapy only

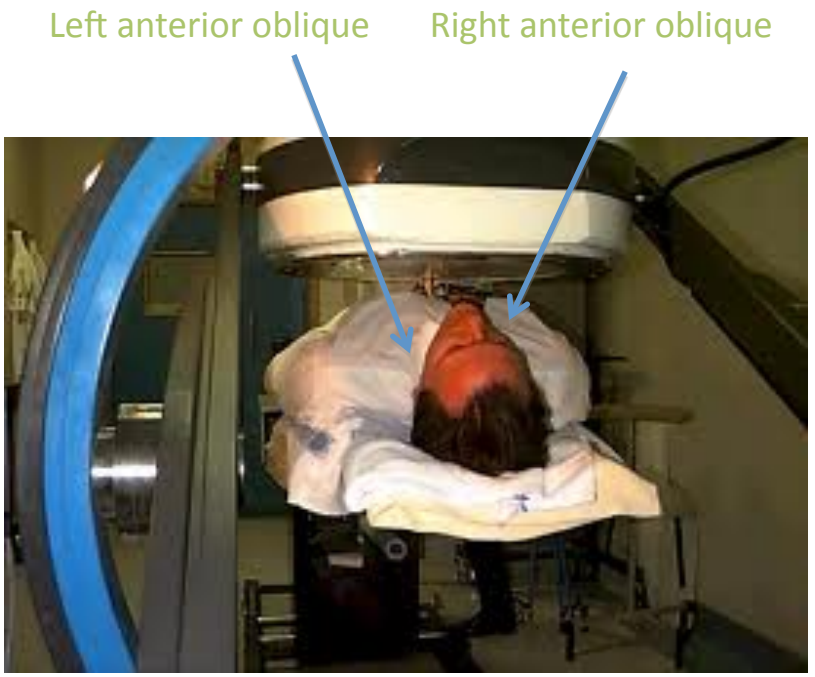
Note

As we said in nuclear lec :

- I 131 is used in treatment and not in diagnosis (has beta radiation), except in cases of thyroid cancers, where it's used in diagnosis (has a long half life: 8hrs).

Note :

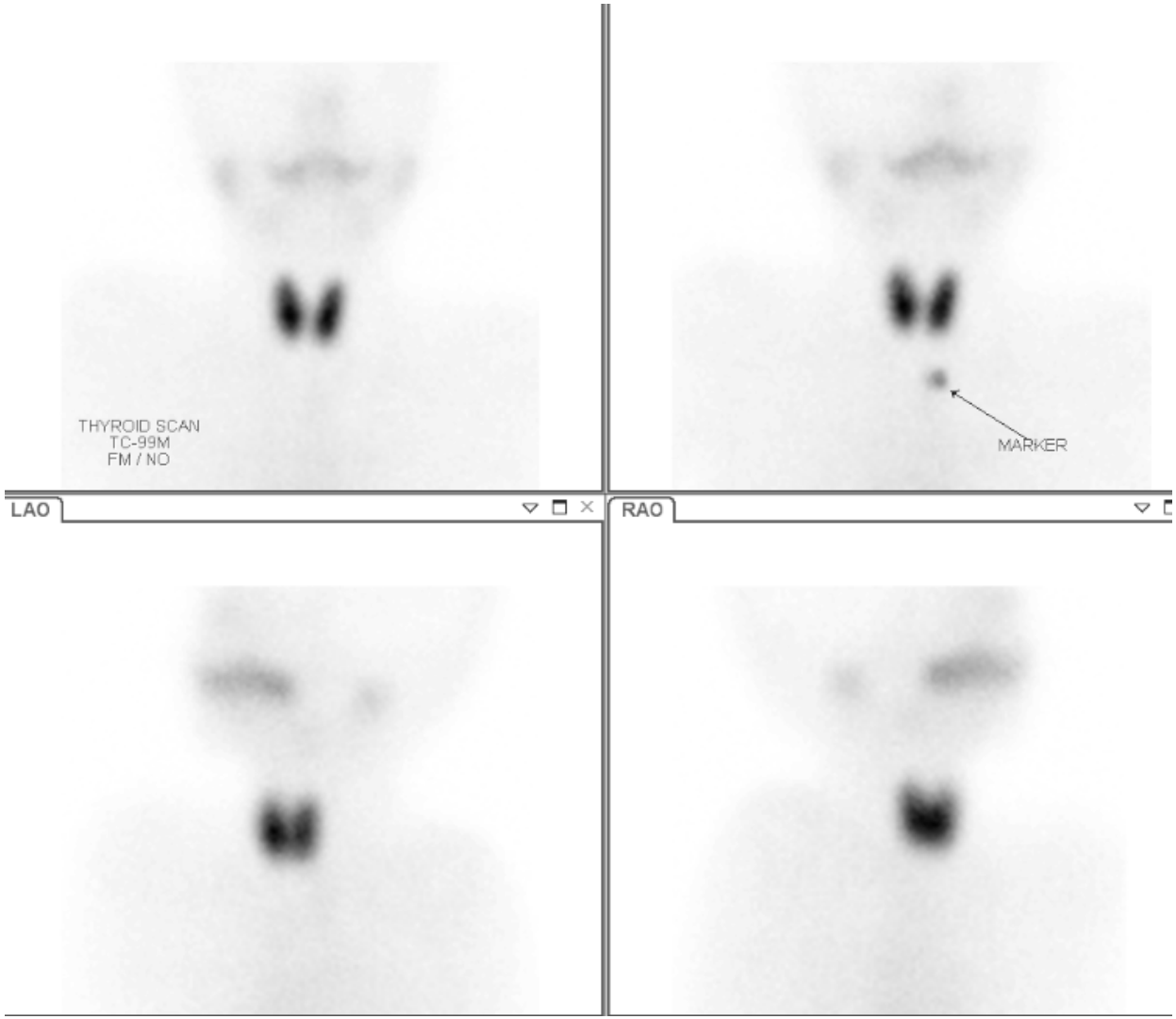
- patient should stop taking medications 2-3 weeks prior to the procedure (thyroxin, anti thyroid drugs, contrasts)



Normal Thyroid Scan

Normal Thyroid Scan

Marker is used to check for retrosternal extension of thyroid



THYROID UPTAKE MEASUREMENT (I-123 Sodium Iodide)

- **The Thyroid Uptake Measurement measures the metabolic activity of the thyroid gland as reflected by its extraction of iodine from the blood.**
- **Indications**
  - **Diagnosis of Grave's disease .**
  - **Evaluation of subacute and chronic thyroiditis .**
  - **Thyroid Cancer**
- **Patient Preparation :**
  - **Must be off thyroid hormones (the hormones interfere with the imaging):**
    1. **Thyroxine (T-4) for at least 3-4 weeks.**
    2. **Triiodothyronine (T-3) for at least 10 days.**
  - **Must not be taking antithyroid medications :**
    - **Propylthiouracil (PTU) and tapazole for at least 3-5 days.**
  - **Must not have had intravenous or intrathecal iodinated contrast material (IVP, CT with contrast, myelogram, angiogram) for at least 3 weeks .**
  - **Other agents may interfere, but usually only to a small extent**
  - **NPO 2-4 hours before and for at least 1 hour after ingesting the radiopharmaceutical**

Note

- Thyroid nuclear scan → images
- Thyroid uptake measurement → counts (numbers/percentages)

Thyroid uptake test is mainly used in :

- diagnosing graves disease
- preparing thyroid cancer patients to treatment
- evaluation of acute and sub-acute thyroiditis

THYROID UPTAKE MEASUREMENT WITH / WITHOUT IMAGING (I-123 Sodium Iodide)

- **Equipment :**
  - **Uptake only : Uptake probe (single crystal probe with flat field collimator).**
  - **Imaging plus uptake studies: Gamma camera**
- **Radiopharmaceutical: dose given orally**
  - **Imaging plus uptake studies: I-123: 500 µCi .**
  - **Uptake study only: I-123: 100 µ Ci**
  - ***Thyroid uptake measurements may be determined using Tc-99m-pertechnetate.***
- **Patient position: Sitting.**
- **Detector field of view: Neck.**

THYROID UPTAKE MEASUREMENT WITHOUT IMAGING (I-123 Sodium Iodide)

1. Place I123 capsule(s) in neck phantom.
2. Acquire counts for 1 minute , record the counts, time of acquisition, and time of day on the thyroid Uptake Worksheet.
3. Immediately administer the capsule(s) to the patient.
4. At 6 hours position the probe in front of the patient's neck .
5. Acquire counts for 1 minute for I-123 and record the counts, time of acquisition, and time of day on the Worksheet.
6. Position the probe over the thigh for 6 hour "background" measurement.
7. Acquire counts for 1 minute for I-123 and for 2 minutes for I-131; record the counts, time of acquisition, and time of day on the Worksheet.
8. Using the Thyroid Uptake Worksheet, calculate the 6 hour thyroid uptakes. **Remember to correct the standard counts for decay.**

Twenty four hour uptake measurement in the same way as the 6 hours.

Normal Values Of Thyroid Uptake

- I131 OR I-123 RAIU (4 & 24 hours) :
  - Normal 4 hour RAIU : 5 - 15%
  - Normal 24 hour RAIU : 8 - 35%
- Tc- 99m Uptake (20 min Uptake):
  N (0.5 -4 .0%)

Know the values

Thyroid Abnormalities

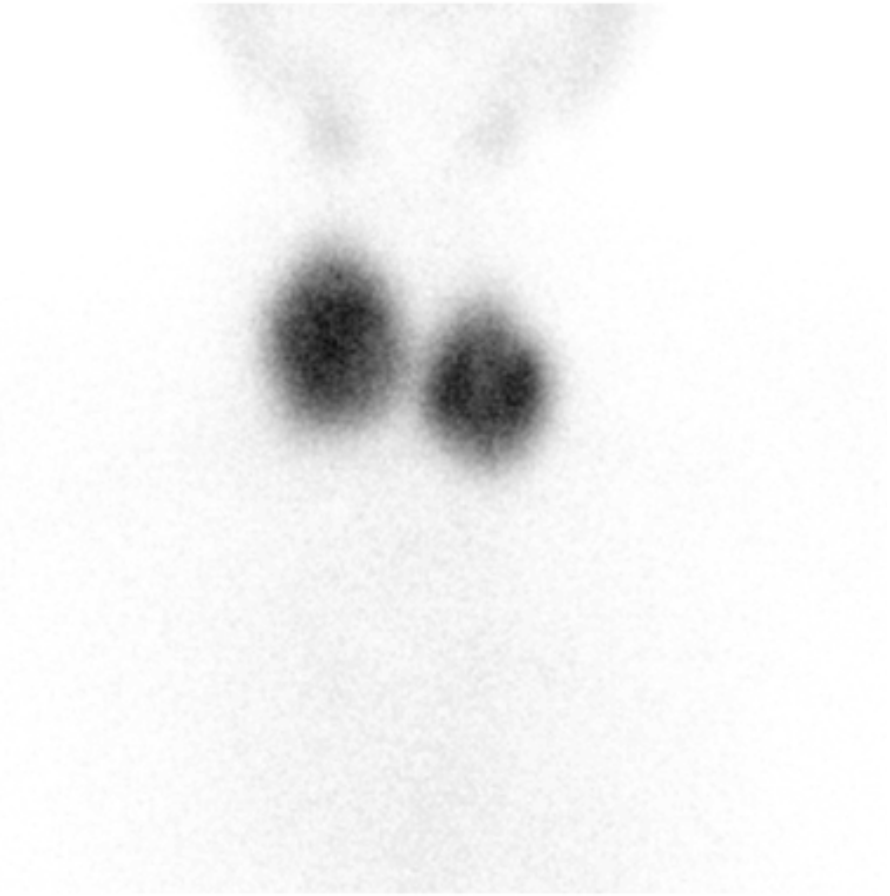
High Thyroid Uptake

Low Thyroid Uptake

Causes of High Thyroid Uptake

1. Hyperthyroidism : Grave's Disease or TSH-secreting pituitary adenoma
2. Autonomous toxic nodule
3. Multinodular toxic goiter (Plumer's Disease)
4. Enzyme defects : Dyshormonogenesis.
5. Iodine starvation (Iodine deficiency)
6. Lithium Therapy
7. Recovery phase of thyroiditis.
8. Rebound following abrupt withdrawal of antithyroid meds

IMP MCQ



THYROID UPTAKE
Tc99m
NA

Causes of Low Thyroid Uptake

1. Parenchymal Destruction:

- Acute, Subacute and Chronic Lymphocytic Thyroiditis

2. Hypothyroidism:

- Primary or Secondary (insufficient pituitary TSH secretion)
- Surgical/Radioiodine Ablation of Thyroid

3. Blocked Trapping:

- Iodine load (most common): Iodinated contrast material, Food rich in iodide: fish , cabbage ,…etc - Exogenous thyroid hormone replacement depressing TSH levels (thyrotoxicosis factitia)
- Ectopic thyroid: Struma Ovarii

4. Blocked Organification:

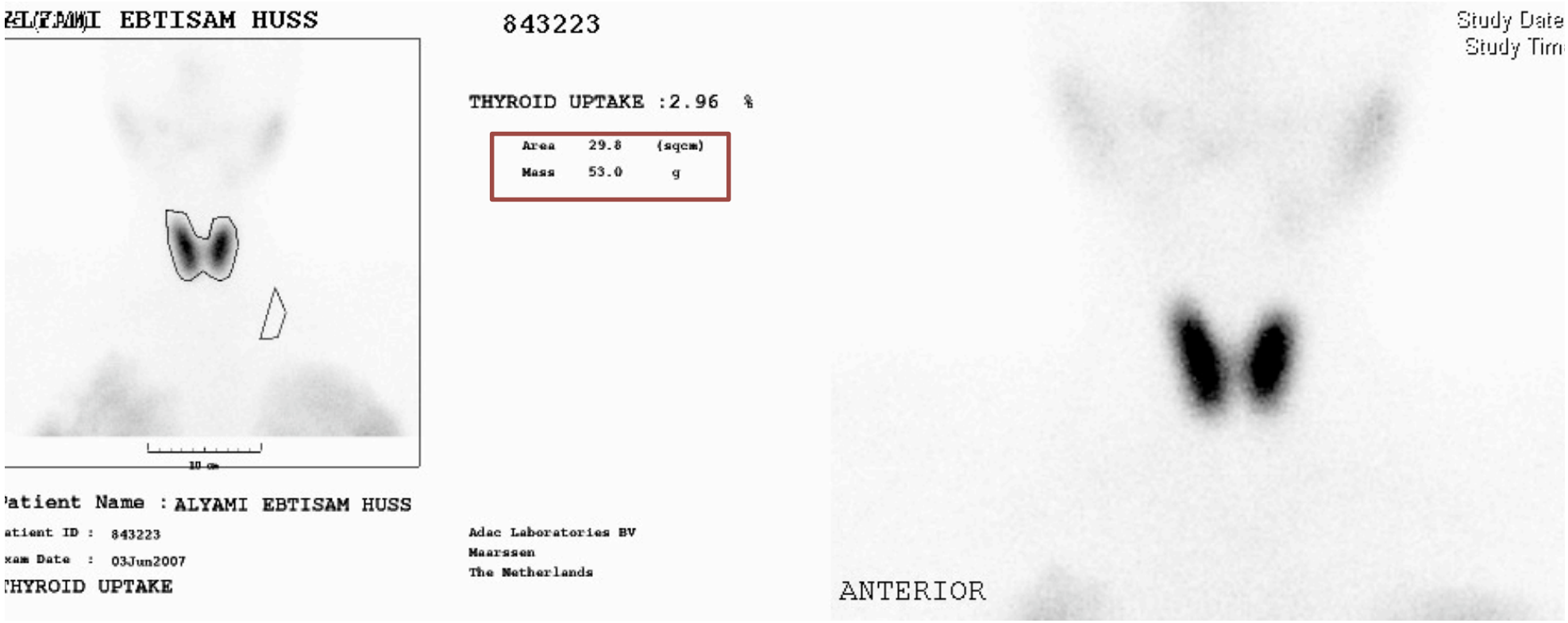
- Antithyroid medication (PTU): Note- Tc-99m uptake should not be affected

IMP MCQ

THYROID UPTAKE
Tc99m
NA

Imaging

Tc-99m Thyroid scan and uptake Imaging plus uptake studies



Here the Thyroid uptake is 2.96 with the Tc-99m which is considered normal (normal range 0.5 – 4.0 %)

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

Indications:

- Detection and localization of persistent or recurrent functioning thyroid cancer

Patient Preparation:

- Stimulation of potentially functioning thyroid tissue:

A. Inject recombinant human thyrotropin on 2 consecutive days and administer the radiopharmaceutical 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 .

Radiopharmaceutical, Dose, & Technique of Administration

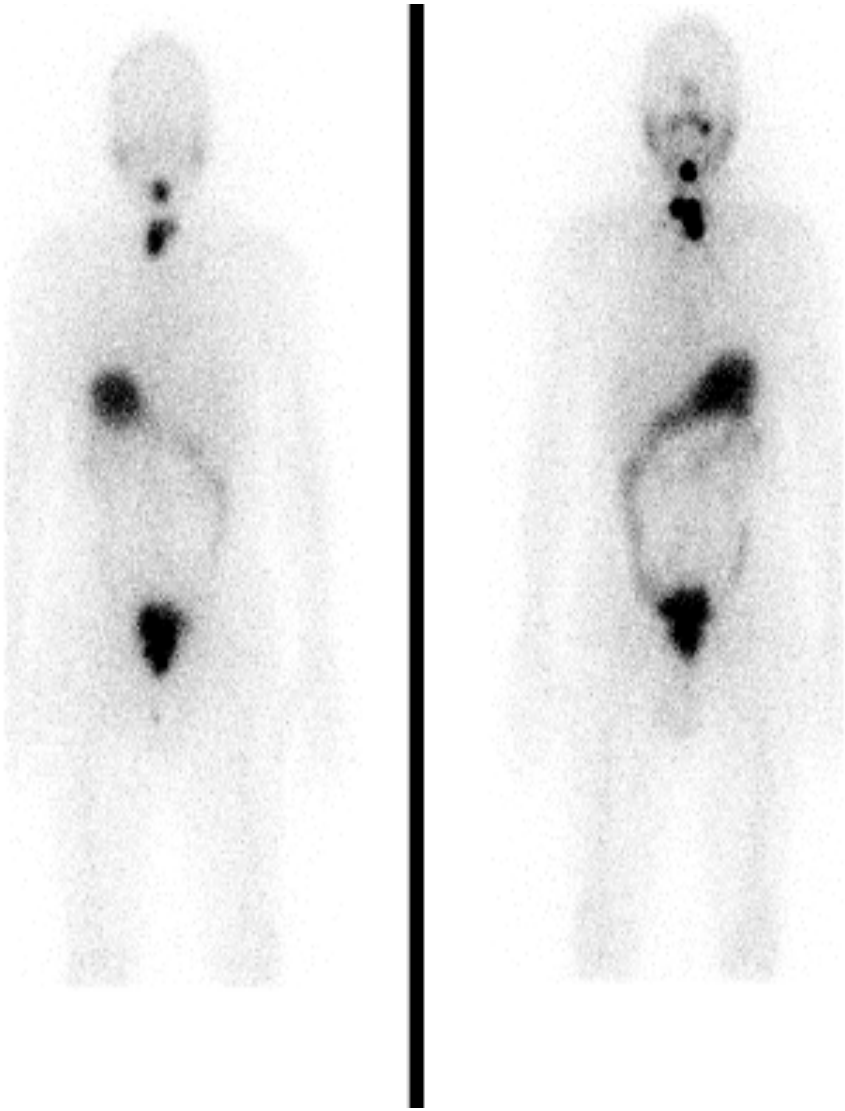
- Radiopharmaceutical: Oral administration

A. I-123 as sodium iodide : 2 mCi

B. I-131 as sodium iodide : 2-10 mCi

Imaging using Gamma camera : Whole body scan

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



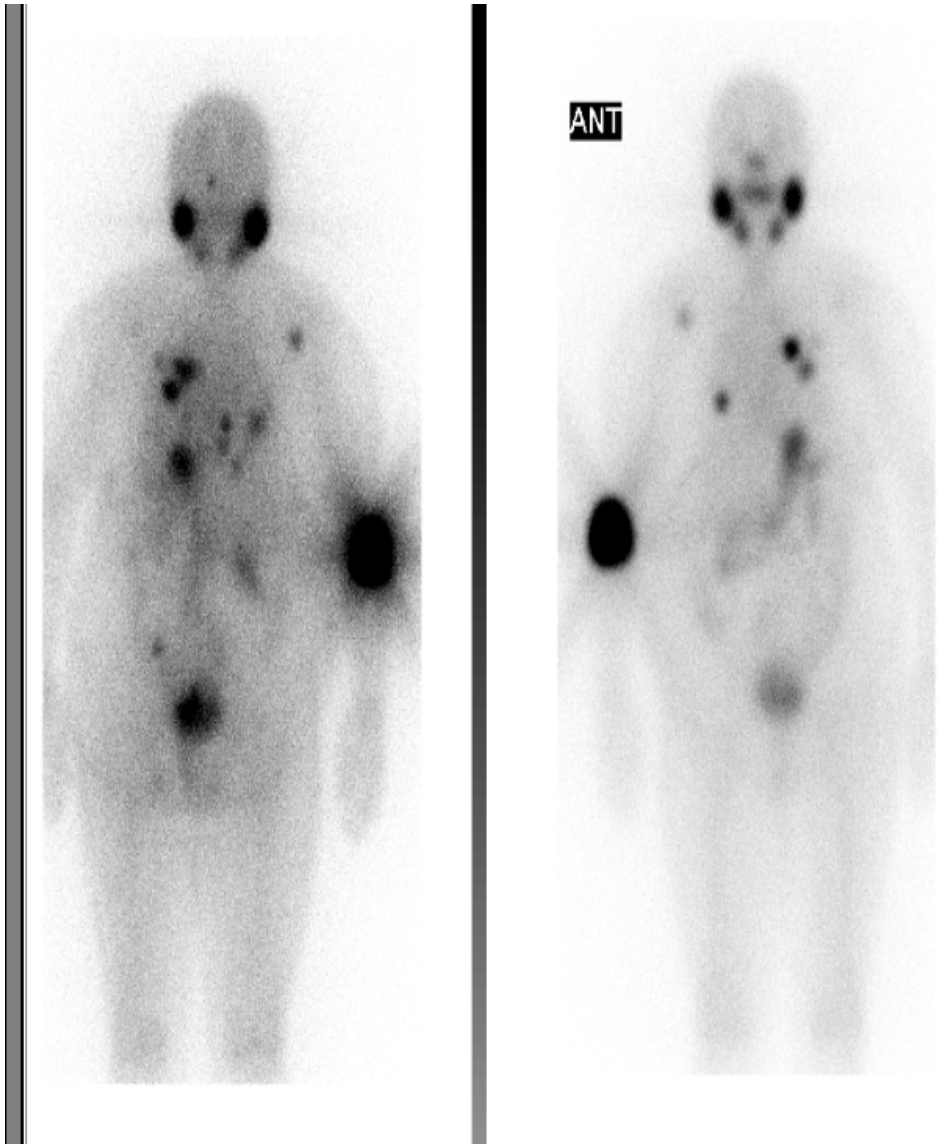
Local Recurrence

Right picture Anterior
Left picture posterior
(check the stomach
to know which is posterior and
which is anterior)

management:

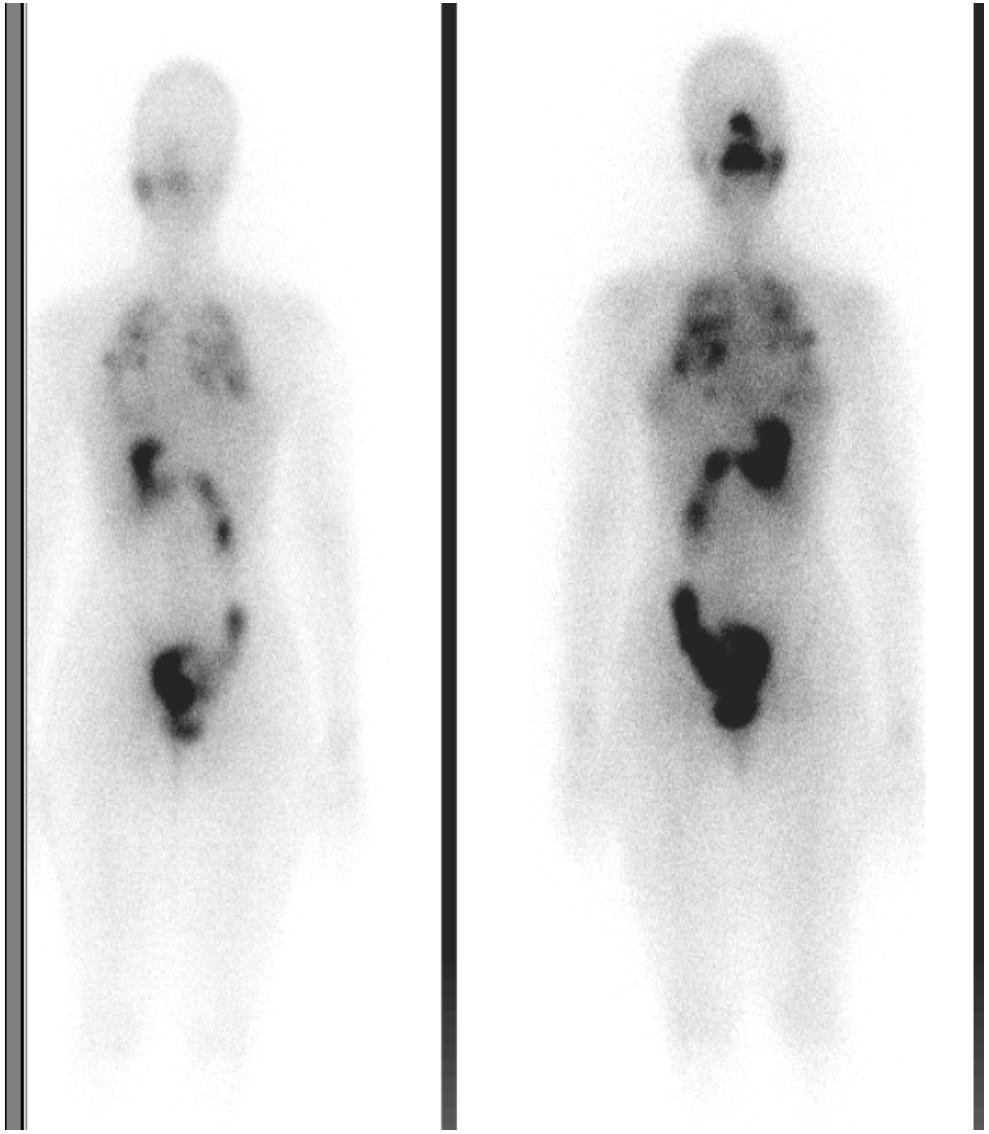
- large remnant: surgery
- small remnant: I131

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



Bone Metastases

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



Lung Metastases

If there is metastasis ..
Thyroid should be removed

When is thyroid scanning helpful? Indications for Thyroid Scan

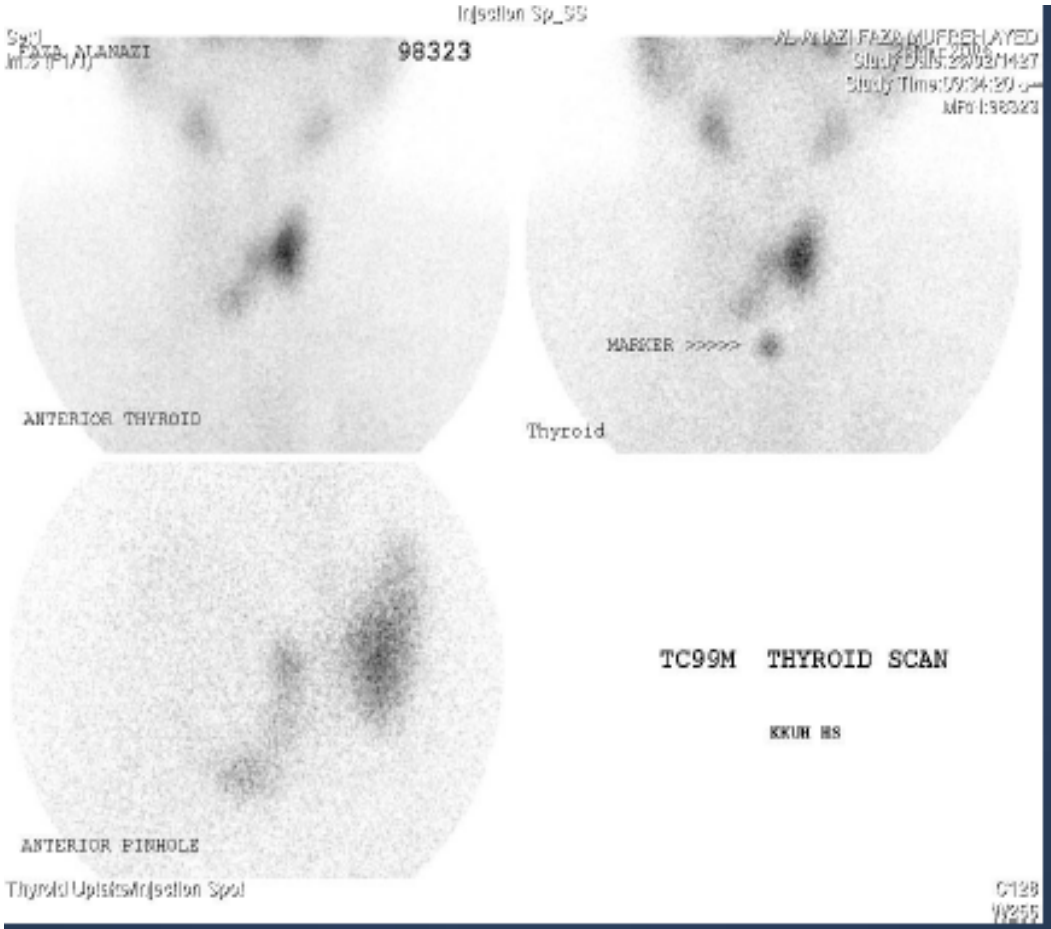
- Evaluation of thyroid nodules : No. & type
- Evaluation of congenital hypothyroidism : Agenesis Vs. Dyshormonogenesis.
- Evaluation of neck masses : ectopic thyroid, thyroglobal cyst.
- Evaluation of thyrotoxicosis.

Evaluation of thyroid nodules
Single vs MNG

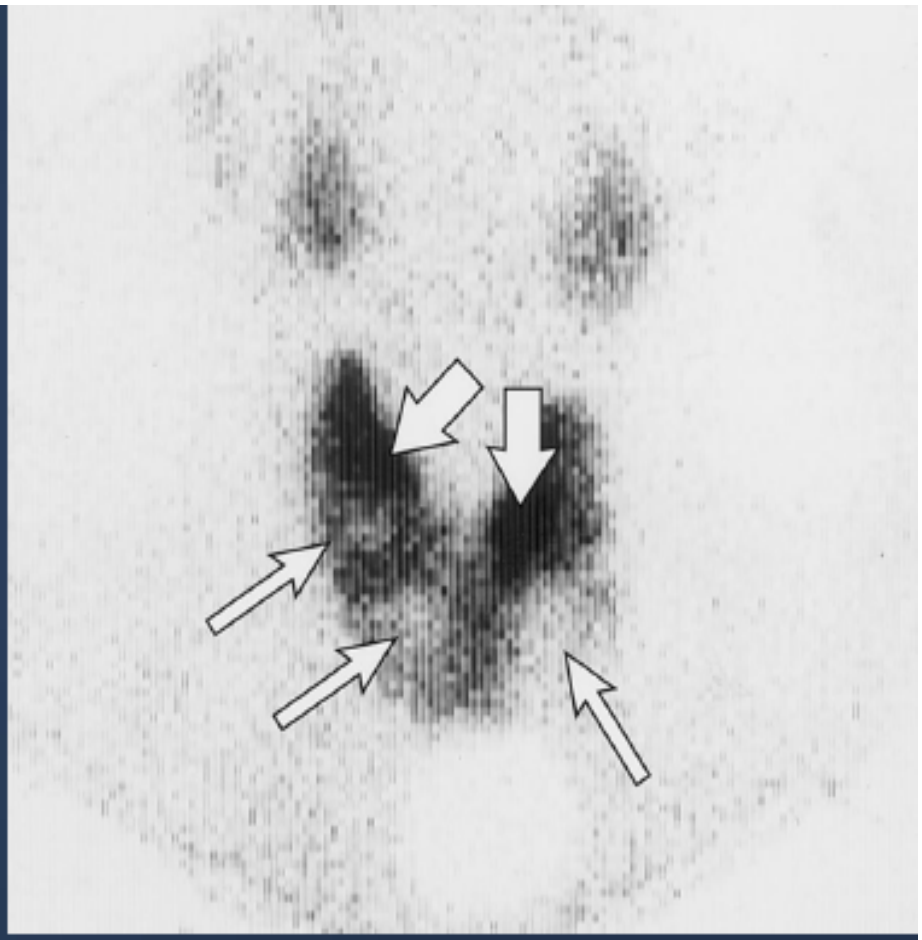
- The chance of malignancy is more in Solitary cold nodule than in MNG
- Cold=low uptake – higher malignancy probability
- Hot=high uptake

Remember: solitary nodule has a chance to 15-20% chance of malignancy

Evaluation of thyroid nodules
Single vs MNG

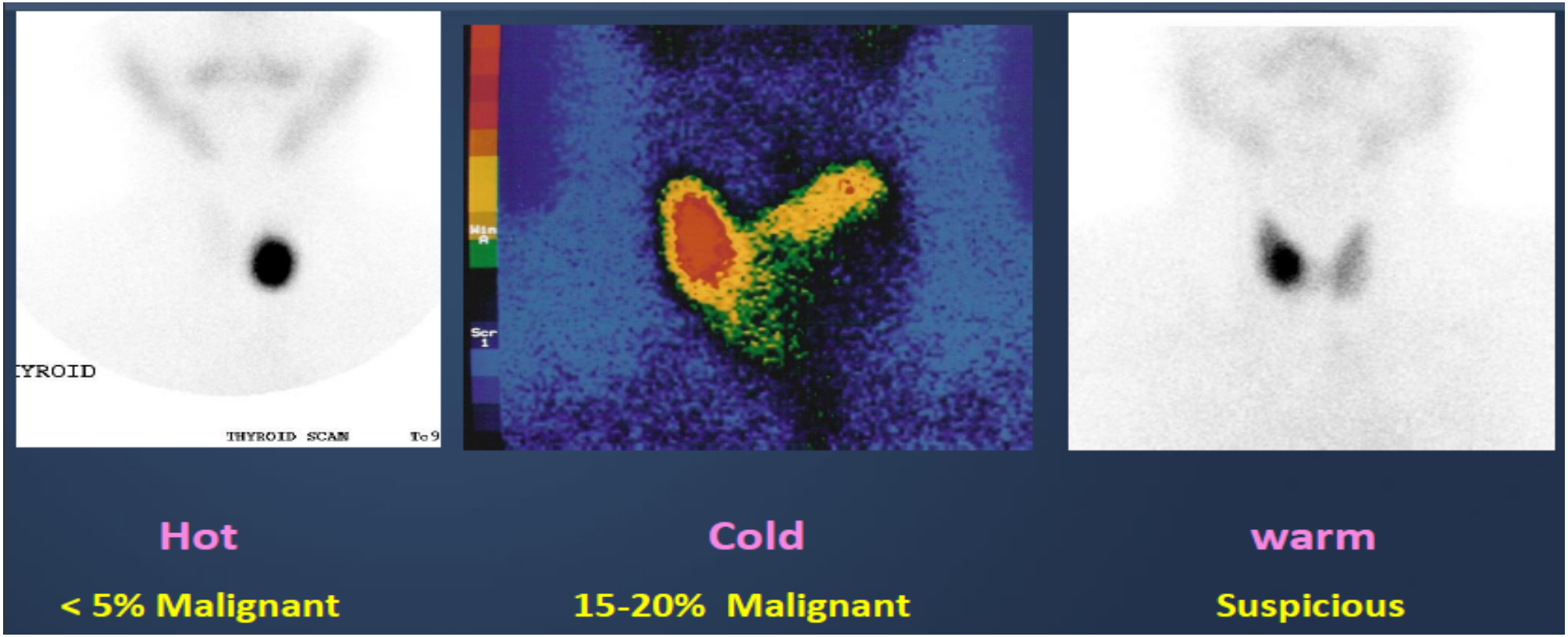


Solitary cold nodule



Multinodular goiter

Evaluation of thyroid nodules
Hot vs Cold vs warm



IMP Note

Hot Nodule :

- a. < 5% are malignant
- b. Autonomus toxic nodule
- c. Produces thyroid hormone → Suppression of TSH
- Very hyperactive that it uptakes all the injected iodine → Thyroid not visible.

- Cold Nodule: The picture is taken by gamma camera (with colors)
  15-20% are malignant

- Warm Nodule:
  Suspicious
  Thyroid hormones is obvious because there is no TSH suppression which is the opposite of a hot nodule. (this is how you differentiate).

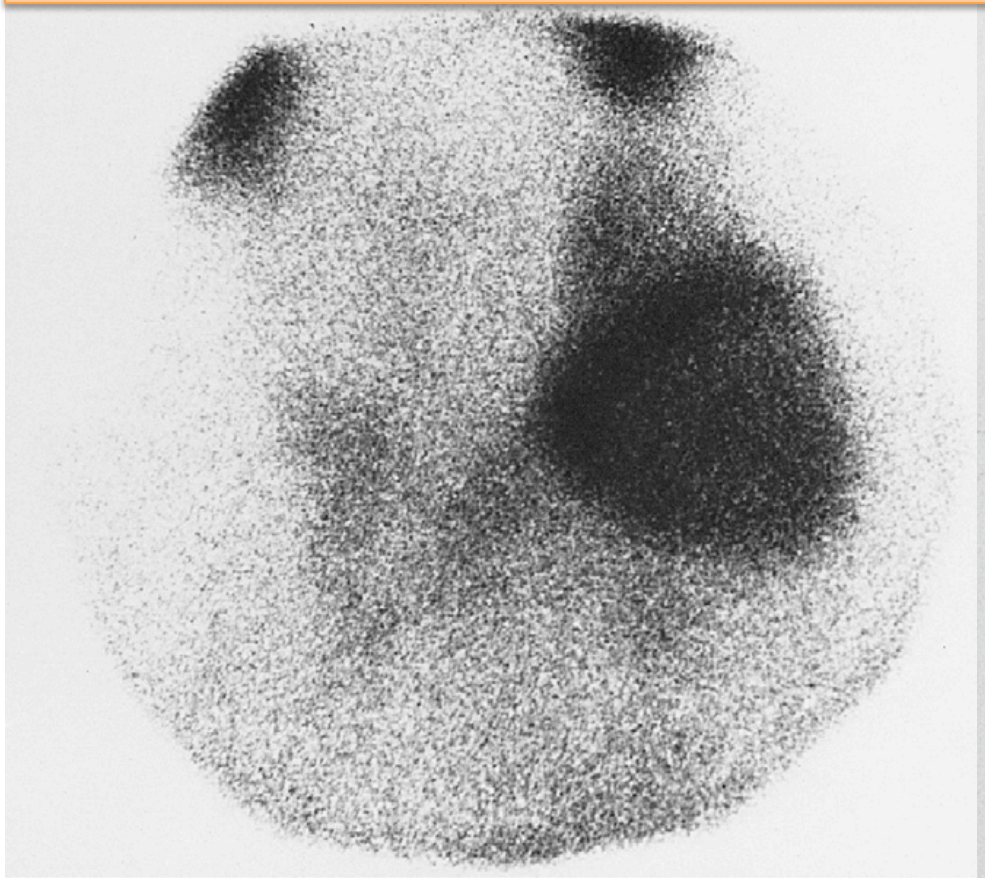
Hot vs Cold vs warm

Nuclear Medicine: The Requisites, Third Edition

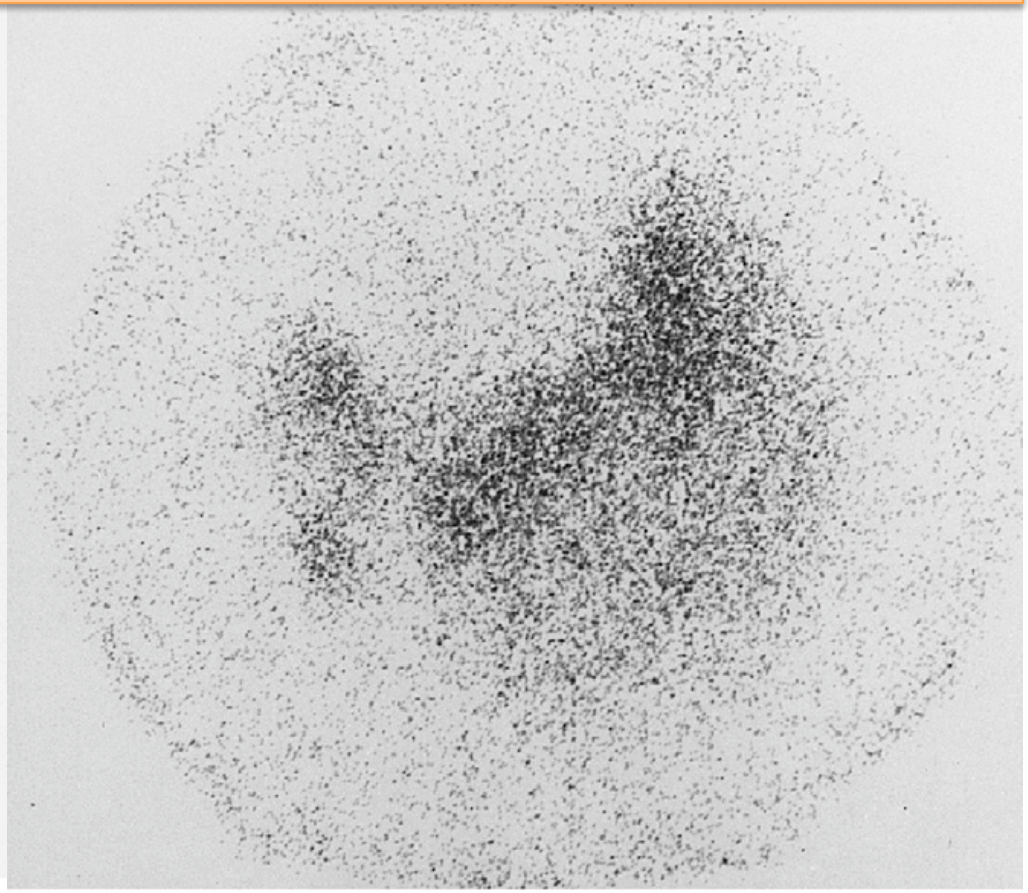
Hot Nodule	Cold Nodule	Warm Nodule
Have high uptake in the nodule scintigraphically, but also have suppression of extranodular tissue	Greater than 85–90% of thyroid nodules are cold (hypofunctional) on thyroid scintigraphy, that is, they have decreased uptake compared to adjacent thyroid tissue.	High uptake in the nodule scintigraphically, extranodular tissue is not suppressed
Hot nodules are caused by toxic adenomatous nodules. Radioiodine I-131 is the usual therapeutic method of choice for toxic nodules. Radiation is delivered selectively to the hyperfunctioning tissue while sparing suppressed extranodular tissues.	Many have benign etiologies,such as simple cysts, colloid nodules, thyroiditis,hemorrhage, necrosis, and infiltrative disorders such as amyloid or hemochromotosis.	Warm nodules may be caused by autonomous hyperfunctioning adenomas. However, they are not toxic, that is, they are not producing enough thyroid hormone to cause thyrotoxicosis and thus TSH is not suppressed.
After successful treatment of the nodule, the suppressed tissue regains function.Surgery,usually lobectomy, may be indicated if there are local symptoms or cosmetic concerns.	However, a significant subgroup of patients with cold nodules has malignancy as the etiology	A warm nodule may also be due to nonautonomous hyperplastic tissue or even normal functioning tissue surrounded by poorly functioning thyroid.

Hot vs Cold vs warm

Nuclear Medicine: The Requisites, Third Edition (Requisites in Radiology)



A



B

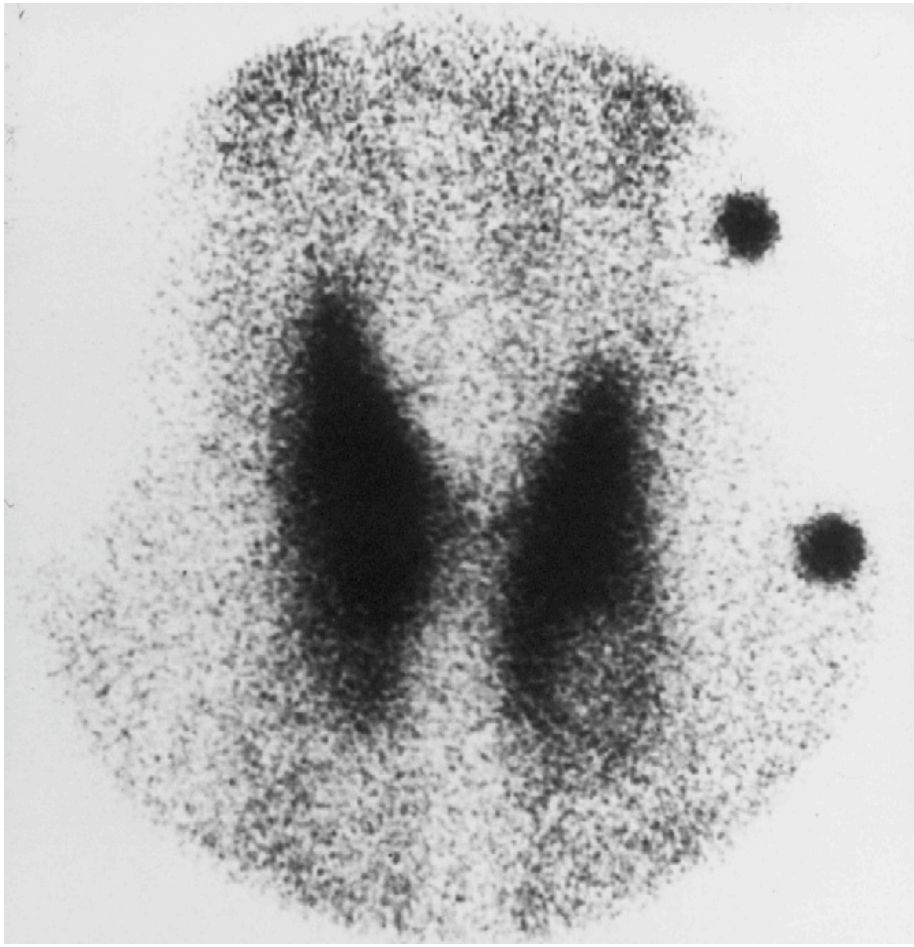
Spontaneous resolution of a hot nodule.

A,Thyroid scan reveals a large, hot nodule in the left lobe of the thyroid.The center of the nodule appears to have less intense tracer activity than the periphery, suggesting central degeneration.

B, Follow-up scan 1 year later reveals complete involution of the hot nodule, with residual distortion of the gland.

Hot vs Cold vs warm

Nuclear Medicine: The Requisites, Third Edition (Requisites in Radiology)



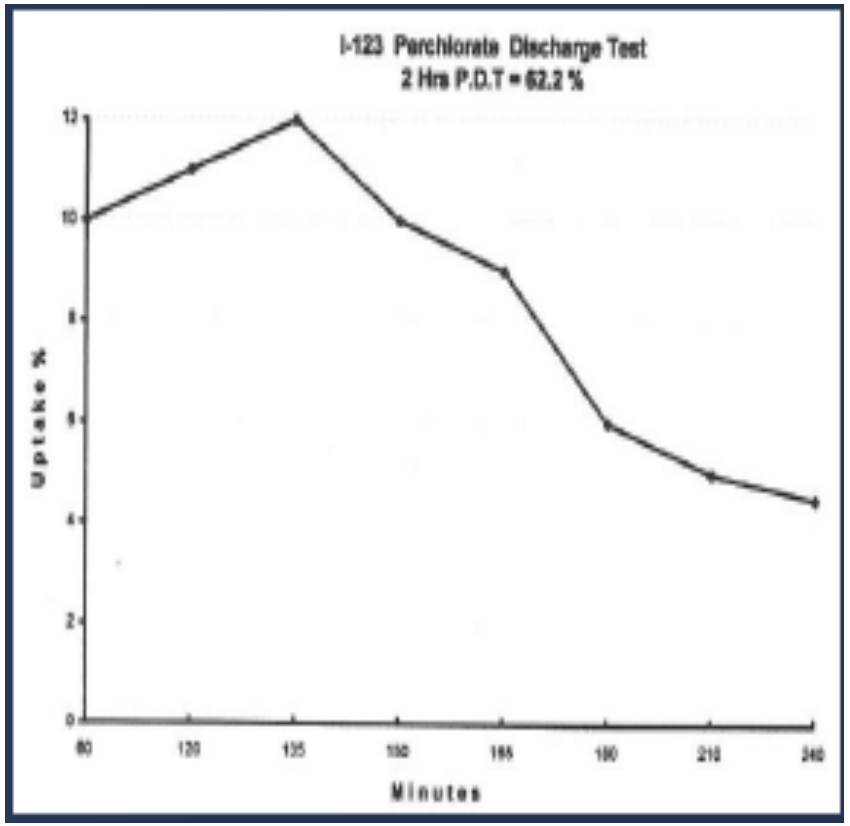
Solitary cold nodule

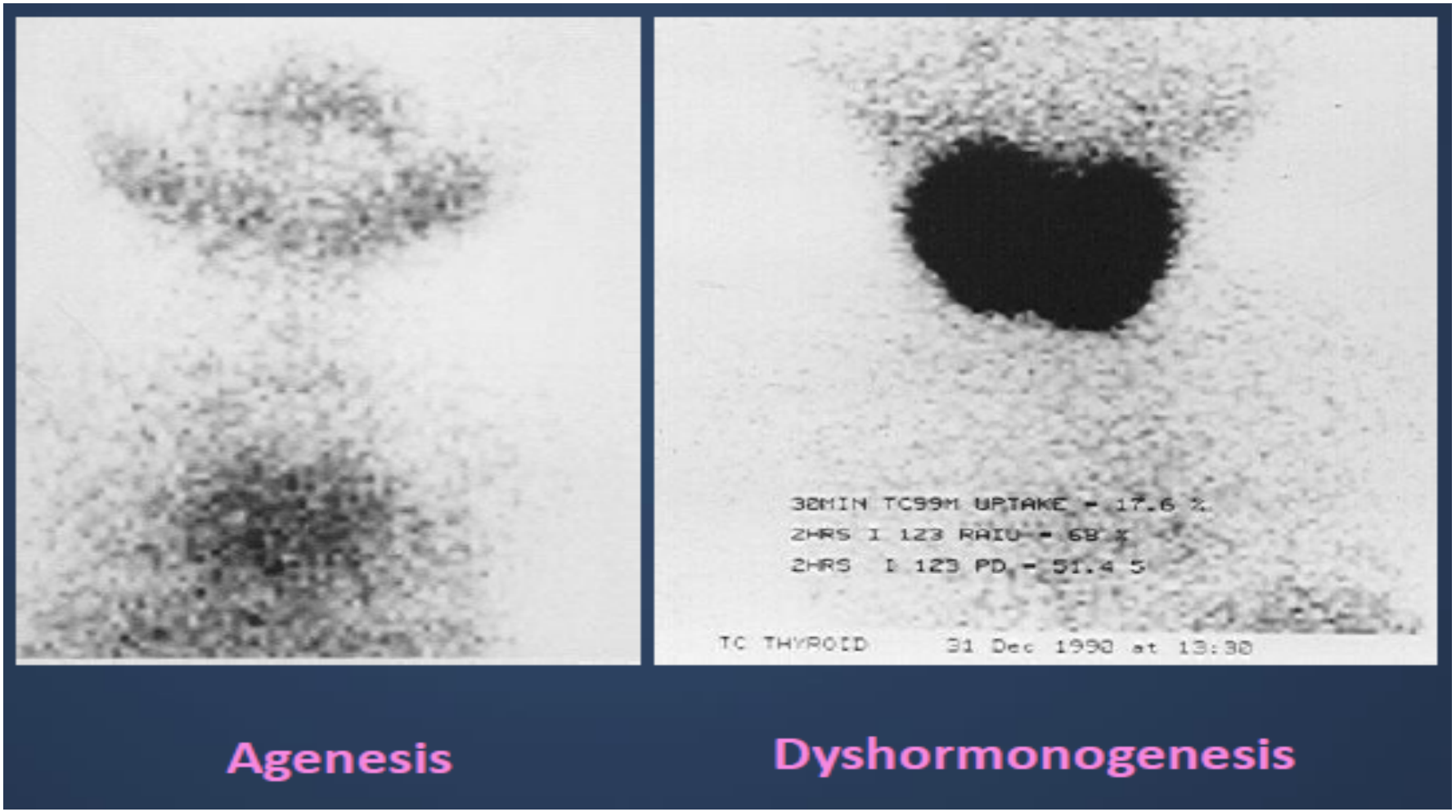
A palpable nodule corresponds to the cold defect in left lower lobe on the thyroid scan. Radioactive markers are placed 4 cm apart on the left side as an aid to approximate the size of gland.

Evaluation of congenital hypothyroidism Agenesis vs Dyshormonogenesis

Perchlorate Discharge Test

- n**50 - 80 uCi I123 orally.**
- n**2 hrs RAIU**
- n**400 mg Kclo4**
- n**RAIU/ 15 min for 2 hrs.**
- n**Positive test : >= 15 fall of RAIU below 2 hours uptake.**





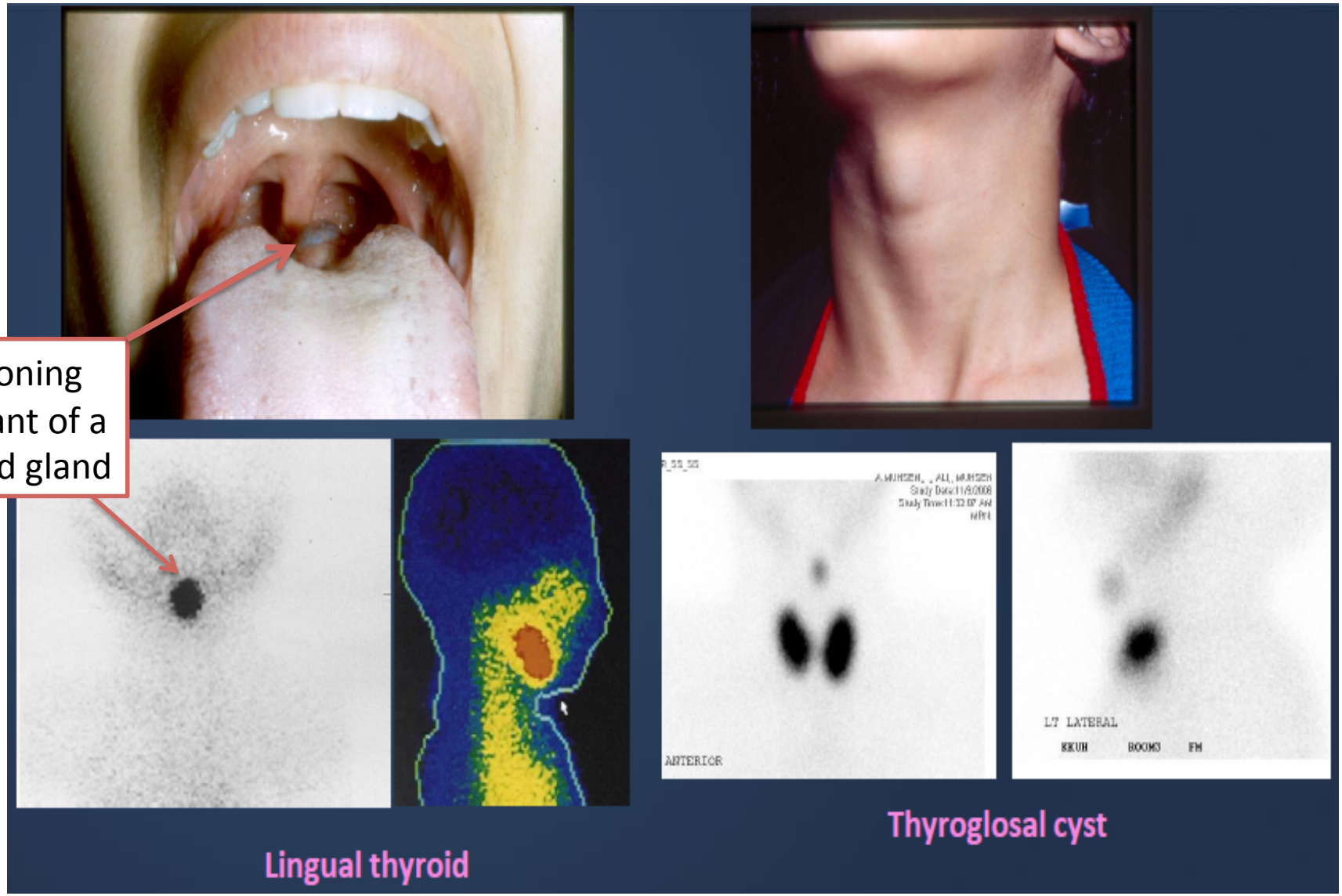
- Agenesis: no thyroid
- Dyshormogenesis: thyroid lacks the enzyme peroxidase (Iodine organification) → no T4, T3 → increased TSH → Increased activity of thyroid without hormone release.

Hyperthyroidism vs. Dyshormogenesis: Perchlorate Discharge Test (measeures the organified Iodines only → low levels in Dyshormogensis

How to differentiate a dyshormonogenesis from a hyper active gland ?

- By a test called Perchlorate discharge test:
- After doing the uptake which is very high, as seen in the picture -> Sodium perchlorate is given (Any Non-organified iodine will be washed out) and then we repeat the uptake, if it drops more than 15% we consider that the test is positive for organification defect and this means it is dyshormonogenesis.

Evaluation of neck masses
Ectopic Thyroid vs Thyroglosal Cyst



Ectopic Thyroid vs Thyroglosal Cyst

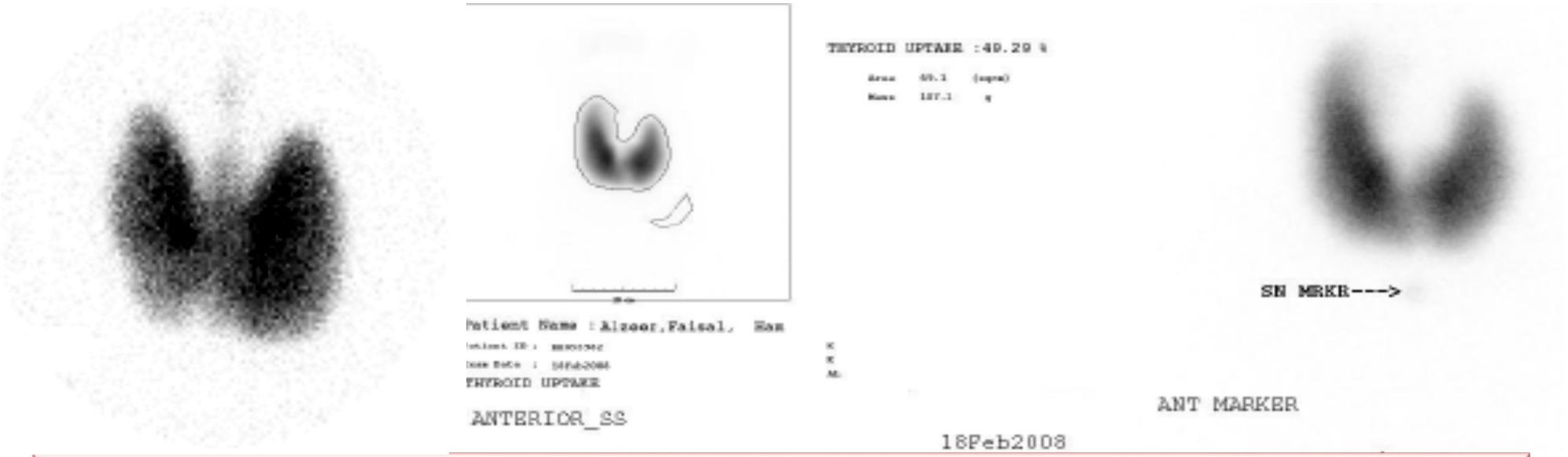
Ectopic Thyroid	Thyroglosal Cyst
Abnormal position to the thyroid gland+ no added (black dots) on the picture. For one or many other reasons the thyroid may fail to reach it's regular site and may settle in an abnormal sites like seen above in the pictures. Ectopic thyroid tissue may also be mediastinal (substernal goiter) or even pelvic/ovarian (struma ovarii).	The thyroid gland is present in its anatomical position + hypoglossal cyst

Evaluation of thyrotoxicosis

- Thyrotoxicosis with hyperthyroidism
  - Graves' Disease .
  - Neonatal hyperthyroidism.
- Toxic nodular goiter:
  - MNTG or Plummers disease
  - ATN or toxic adenoma
- Iodine induced (Jod-Basedow disease)
- Rare causes:
  - Excessive HCG by trophoblastic tumor
  - Hypothalamic pituitary neoplasms (TSH induced)

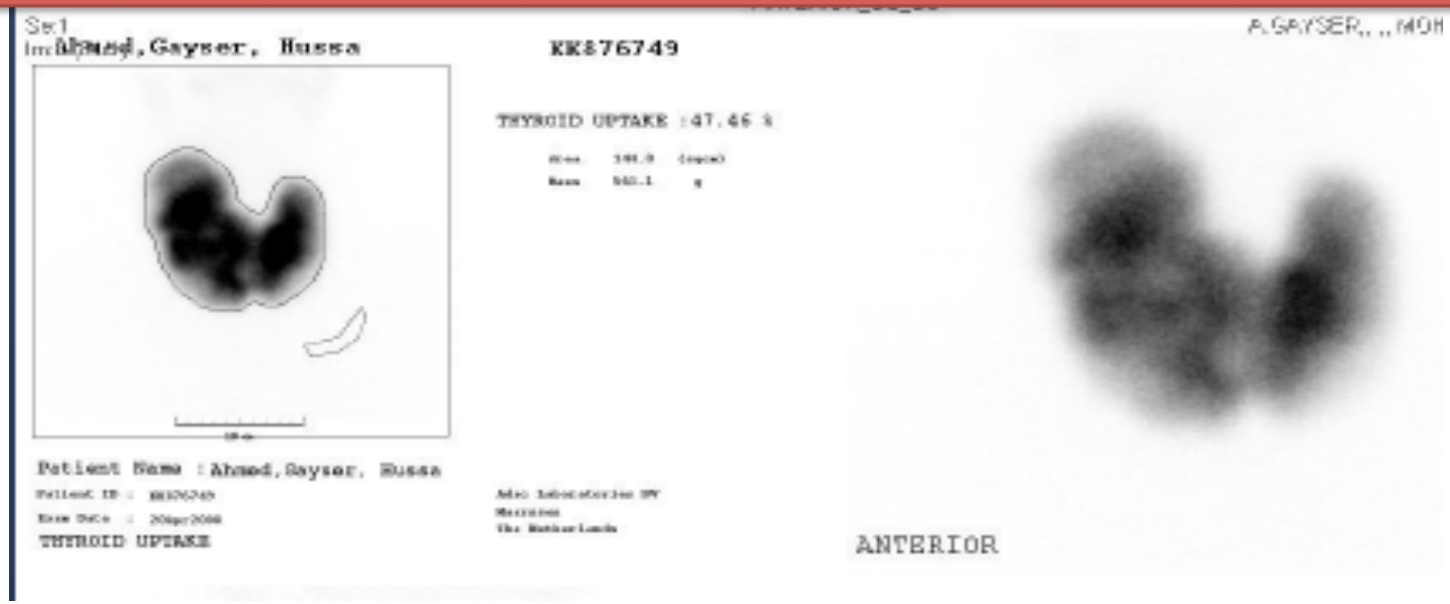
Evaluation of Thyrotoxicosis

- Thyrotoxicosis **IS NOT** synonymous to Hyperthyroidism
- Thyrotoxicosis: Is a complex of signs and symptoms due to elevated thyroid hormones in the blood
- Hyperthyroidism: Overproduction of thyroid hormones by the thyroid gland (hyperactive gland)



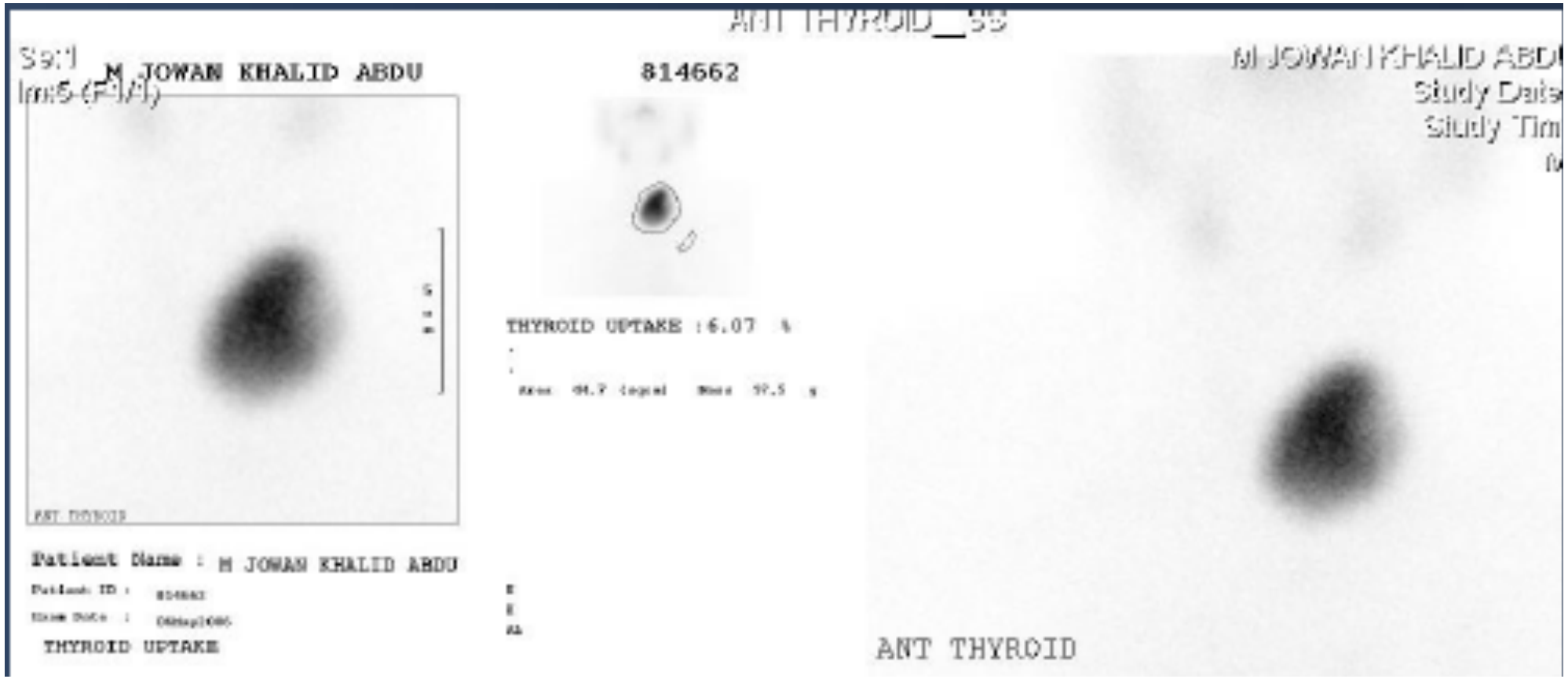
Grave's Disease

Diffuse enlargment of the gland with an uptake of 49% (normally 0.5-4.0% for the TC-99m).



Multinodular Non-toxic Goiter MTNG

Diffuse enlargement with a high uptake (47.5%) but it is multinodular.



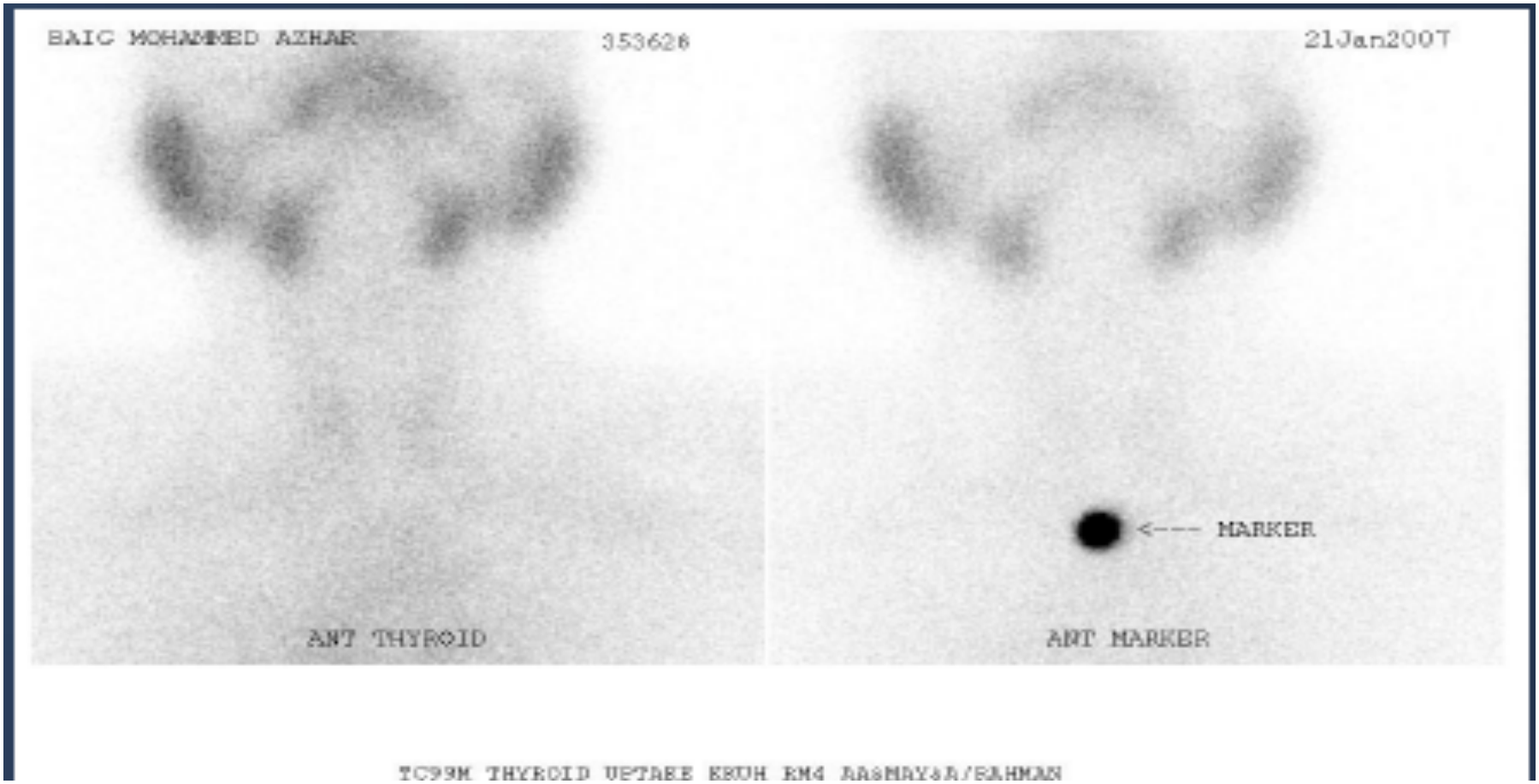
Autonomous Toxic Nodule ATN

Grave's Disease	Multinodular Non-toxic Goiter	Autonomous Toxic Nodule
Between 70% and 80% of patients presenting with thyrotoxicosis have Graves' disease as the etiology. This autoimmune disease is most commonly seen in middle-aged females but also occurs in children and the elderly.	Sometimes referred to as *Plummer's disease,multinodular goiter often presents* in older patients with tachyarrhythmias, weight loss, depression, anxiety, and insomnia	Occurs more frequently in the elderly and those living in iodine deficient regions. Once an autonomous nodule grows to a size of 2.5–3.0 cm, it produces enough thyroid hormone to cause clinical thyrotoxicosis
Scintigraphic pattern : Diffuse homogenous increased uptake of Graves' disease. A thyroid scan is often not necessary to confirm Graves' disease if physical examination or sonography is consistent with diffuse goiter without nodules.	Toxic nodular goiter has the characteristic scintigraphic pattern of increased uptake that corresponds to palpable nodules and suppression of extranodular thyroid tissue.	The %RAIU is usually in the normal range and the thyroid scan shows uptake in the nodule but suppression of the remainder of the gland.
The pyramidal lobe, a paramedian structure arising superiorly from the isthmus (right or left lobe), is also usually well visualized *with Graves' disease*	The thyroid scan has the classical picture of high uptake within hyperfunctioning nodules but suppression of the extranodular tissue due to pituitary feedback and TSH suppression. Therapy with radioactive iodine I-131 is the usual treatment.	Therapy is often with radioactive iodine, although surgery is a treatment choice.

Evaluation of Thyrotoxicosis

- Thyrotoxicosis without hyperthyroidism
  - Subacute thyroiditis.
  - Chronic thyroiditis with transient thyrotoxicosis
  - Thyrotoxicosis factitia (exogenous hormone).
  - Thyroid extract (e.g.Hamburger thyrotoxicosis)
- Ectopic thyroid:
  - Metastatic thyroid carcinoma
  - Struma ovari

Subacute Thyroiditis SAT



Subacute Thyroiditis SAT

- The most common reason for thyrotoxicosis associated with a decreased %RAIU (radioactive iodine uptake) is subacute thyroiditis.
- The decreased %RAIU associated with subacute thyroiditis is the result of an intact pituitary feedback mechanism, not because of damage and dysfunction of the gland. Uptake is suppressed in the entire gland, but the disease is often patchy or regional.
- During the initial stage of subacute thyroiditis, stored intracellular thyroid hormone is released into the blood. This is caused by increased cell permeability as a result of the inflammatory process.
- The level of the %RAIU depends on the damaged thyroid's ability to respond to TSH stimulation. The hypothyroidism usually resolves over weeks and months and the TSH and %RAIU return to normal. The rapidity of this process depends on the degree of damage. The %RAIU depends on the stage of the disease

Nuclear Medicine: The Requisites, Third Edition (Requisites in Radiology)

Radioactive Iodine Therapy for Hyperthyroidism

- Isotope used: I131
- Physical Properties: Solution or capsule
- Main side effect: Hypothyroidism
- Dose:
  a. Calculated: Considering weight and uptake of the gland
  b. Empirical:
    - Graves: 5-15 mCi
    - ATN : 15-20 mCi

Radioactive Iodine Therapy for Thyroid Cancer

- Isotope used: I131
- Physical Properties: Solution or capsule
  - Thyroid remnant : 80-100 millicurie
  - Lymph Node Mets : 100 mCi
  - Local Recurrence : 100 mCi
  - Lung Mets : 150 mCi
  - Bone Mets : 200 mCi

IMP !!

- Metastasis therapy:
- Patient should be hospitalized and the treatment start by giving Iodine-131 with a specific doses for each metastasis .
- Patients are Isolated until the radiation goes down to 30 mCi.
- (contraindicated in brain metastasis → it may cause brain edema).

Box 5-9 Relationship of Thyroid Uptake to Thyroid Function

	Thyroid Uptake		
THYROID FUNCTION	**INCREASED**	**NORMAL**	**DECREASED**
Thyrotoxicosis	Graves' disease Hashitoxicosis	Antithyroid drugs Propylthiouracil Methimazole	Expanded iodide pool Subacute thyroiditis, thyrotoxic phase Thyrotoxicosis factitia Antithyroid drugs Struma ovarii
Euthyroid	Rebound after antithyroid drug withdrawal Recovery from subacute thyroiditis Compensated dyshormonogenesis		Decompensated dyshormonogenesis
Hypothyroid	Decompensated dyshormonogenesis Hashimoto's disease	Hashimoto's disease after I-131 therapy Subacute thyroiditis, recovery phase decompensated dyshormonogenesis	Hypothyroidism: primary or secondary

Parathyroid

Parathyroid Scan

Tc-99m Sestamibi (Dual Phase)

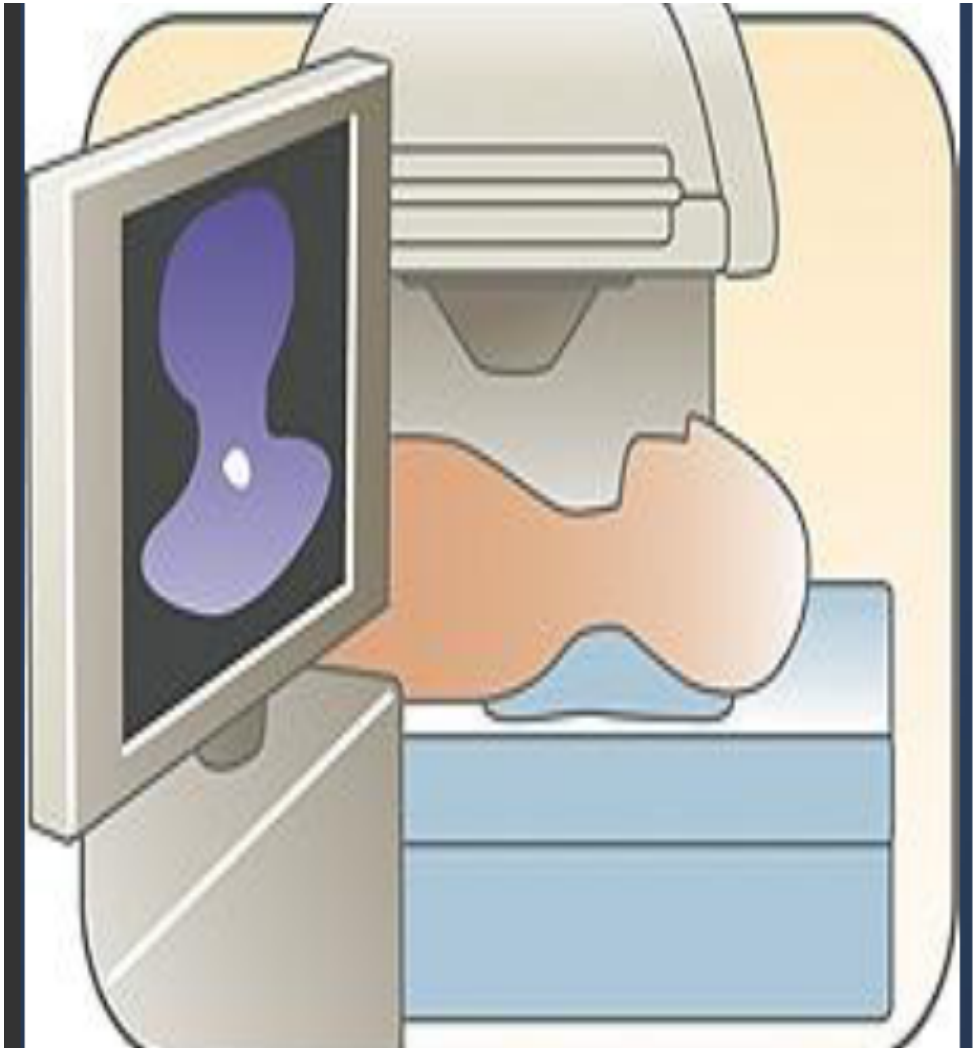
Tc-99m Tetrofosmin (Dual Phase)

Parathyroid Scan
LEARNING OBJECTIVES

At the end of the lecture you will be able to answer the following questions:

- Discuss the principles of dual-phase and dual-isotope parathyroid imaging.
- Identify the common imaging features of pathologic parathyroid glands.
- Discuss causes of false negative scans.
- Identify causes of false negative and false positive scans.

Parathyroid Scan



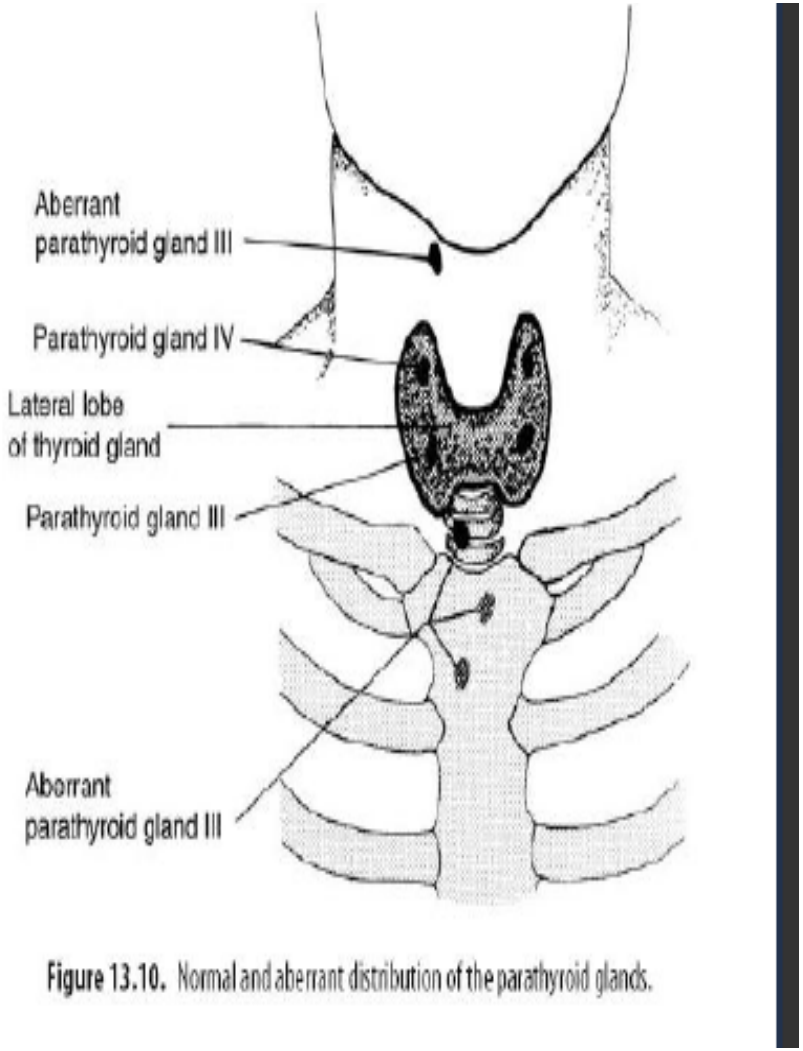


Figure 13.10. Normal and aberrant distribution of the parathyroid glands.

Parathyroid Scan Techniques

- TL-201 _ Tc-99m subtraction:
  - Thalium TL: absorbed by thyroid + parathyroid
  - absorbed by thyroid only
  - Subtraction of the count of Tc-99m test from TL test gives you the absorption count of the parathyroid gland only
- Tc-99m Sestamibi (Dual Phase)
- Tc-99m Tetrofosmin (Dual Phase)

Parathyroid Imaging

Radiopharmaceutical	99mTc / 201Tl Subtraction	99mTc sestamibi
Activity administered	80 MBq (2 mCi) 201Tl; 370 MBq (10 mCi) 99mTc	925 MBq (25 mCi)
Images acquired	Inject Tl .rst and acquire 15-min count view of neck and mediastinum. Then acquire similar Tc images without moving patient. Subtract Tc data from Tl after normalization to equal count densities	Anterior (and oblique) views at 15 min and at 2–3 h; SPECT as needed

Parathyroid Imaging

Tc-99m-Sestamibi

- The Parathyroid Study depicts hypertrophied parathyroid tissue, probably because of uptake of Tc-99m-sestamibi in the mitochondria of hyperactive cells.

It will absorbed by thyroid and parathyroid glands then it will concentrate on the parathyroid to detect its disease

1.Indications: Detect and localize parathyroid adenomas .

2.Patient Preparation: None.

3.Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: 25 mCi Tc-99m-sestamibi i.v.
- Patient position: Supine with head and neck extended and immobilized.
- Gamma camera Imaging field: Neck, Upper two thirds of the mediastinum.

Acquire images at 15 minutes and 2-3 hours post injection.

SPECT images improves localization.

TI – Tc99m subtraction: Several protocols have been developed for routine subtraction of thyroid tissue from parathyroid tissue

Use thelium , thelium will absorbed by the thyroid and parathyroid glands then it will concentrate in the thyroid. which will detect the disease on the parathyroid gland

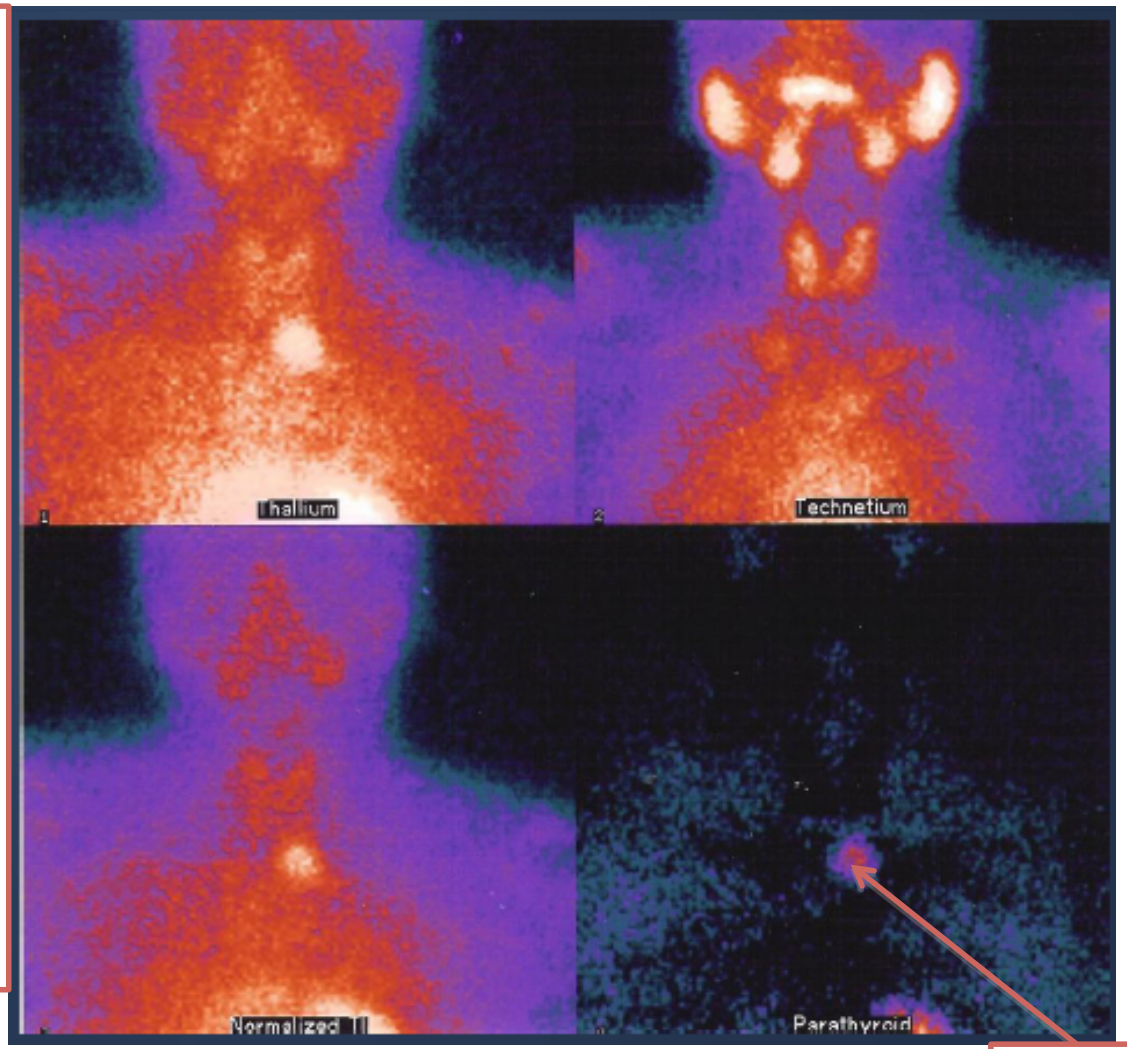
Parathyroid Scan (Tc-Tl Subtraction Scan)

Tc-Tl subtraction scan

Thalium is given → goes to the thyroid and parathyroid glands

Technetium is given → goes to thyroid

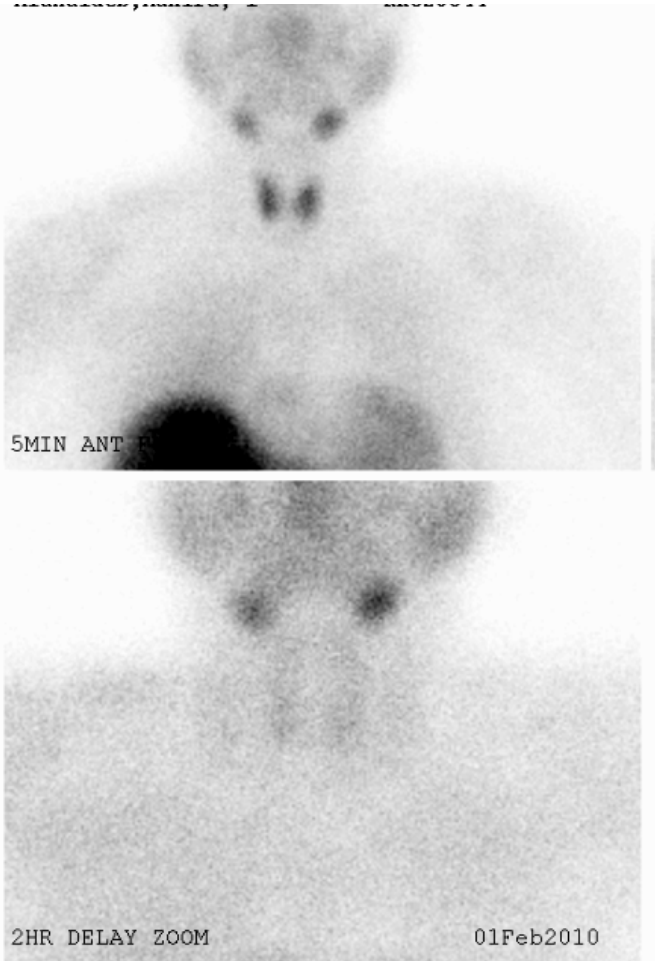
We subtract both images and any abnormality will appear (taked around 40 minutes and the patient should be still and not moving)



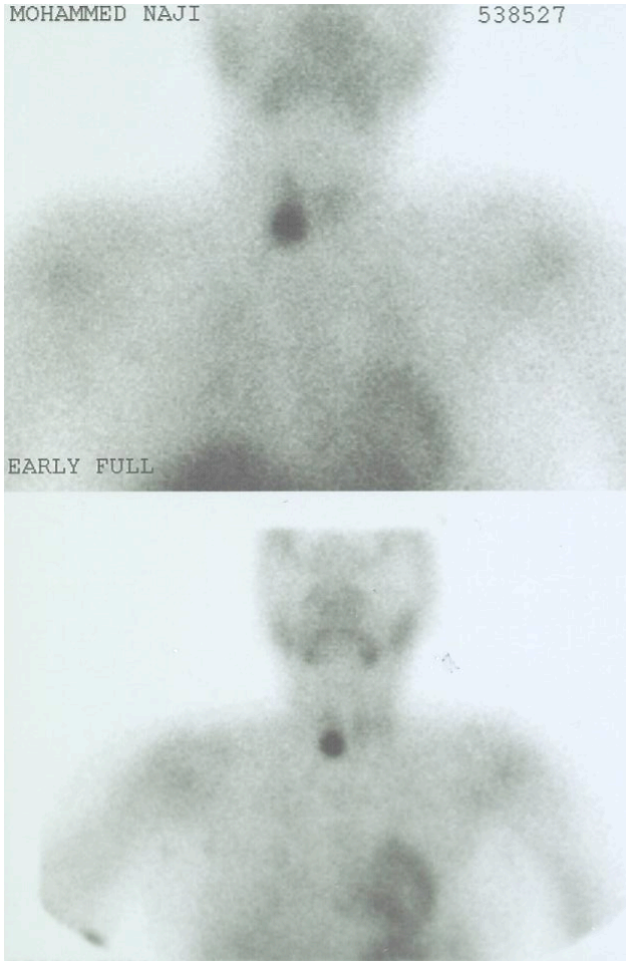
After subtraction

Parathyroid Scan

Dual phase MIBI Scan (Or Tetrofosmin)



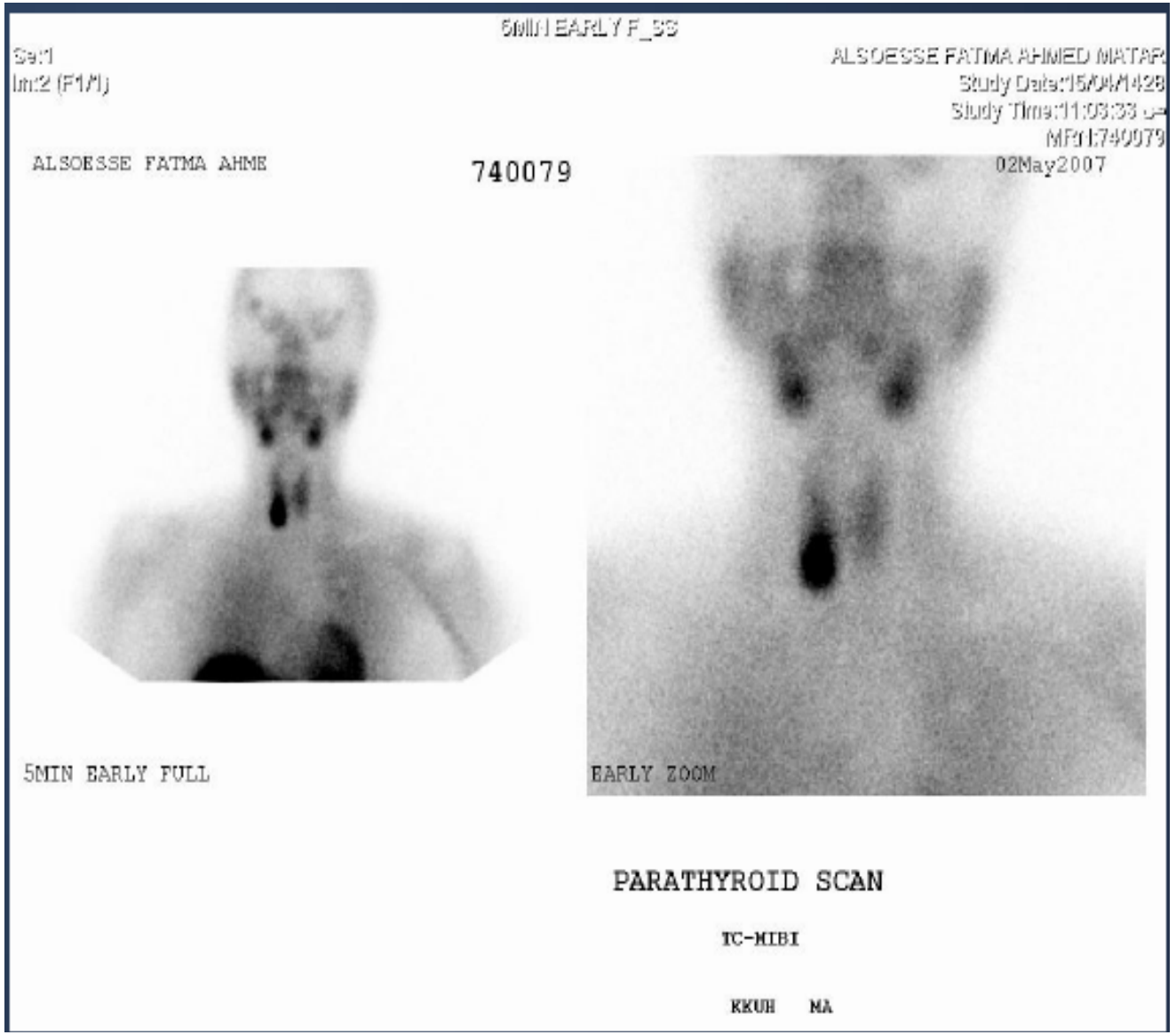
Normal parathyroid glands are small and NOT visualized



Abnormal parathyroid glands could be visualized

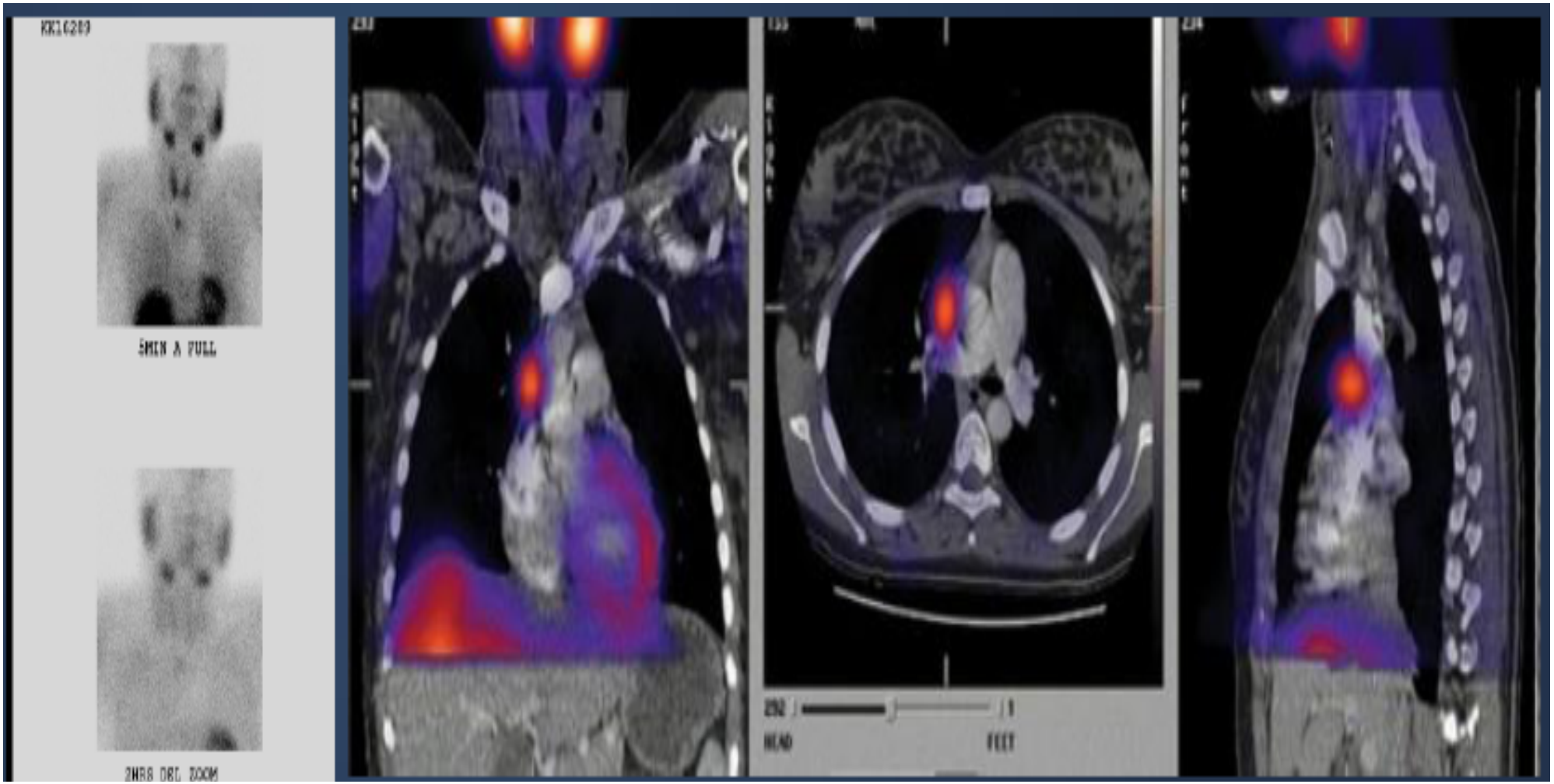
Parathyroid Scan (Sestamibi dual phase)

Early phase → thyroid and abnormal parathyroid glands.
Late phase → washed out of glands. Only abnormal parathyroid



Parathyroid Scan Ectopic Parathyroid

PLANAR vs SPECT/CT

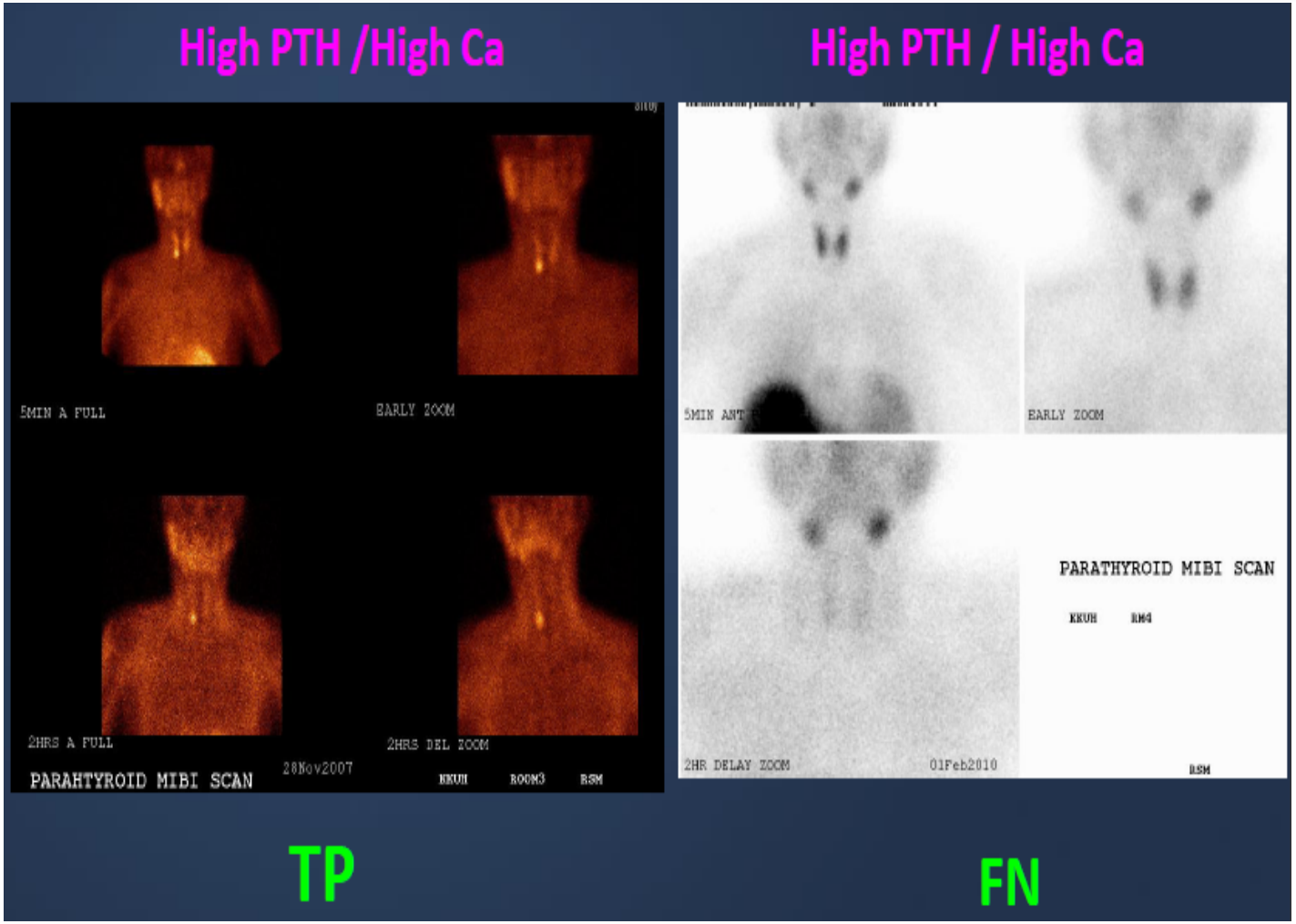


SPECT-CT images accurately localize the adenoma and guide the surgeon to the best surgical approach

SPECT/CT will tell you exactly the location of the ectopic parathyroid gland.

Sestamibi Parathyroid Scan Result

True positive right lower parathyroid adenoma



False negative: when Chief cells are more than Oxyphill cells

Q:What is the cause of the FN result…? A: Mechanism of sestamibi uptake

To prove abnormal parathyroid → 2 imaging modalities must be done (e.g. MRI + Nuclear)

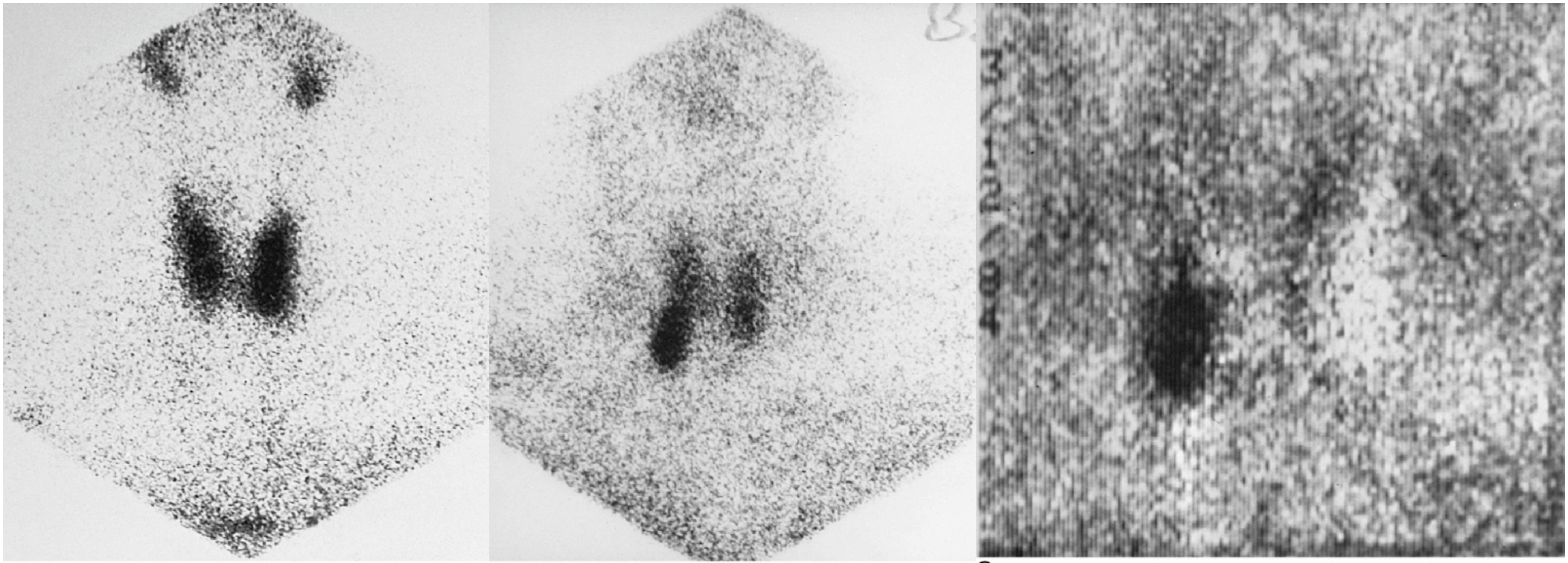


Figure 5-30 Thallium-21/Tc-99m pertechnetate parathyroid subtraction scan.Patient has hypercalcemia and increased serum parathormone level. **A, Tc-99m pertechnetate scintigraphy in** a patient is essentially normal. **B, Corresponding Tl-201 scintigraphy reveals an apparent area of** increased uptake adjacent to the lower pole of the right lobe. **C, Subtraction of the Tc-99m** pertechnetate study from the T1-201 study confirms the presence of the parathyroid adenoma.

Nuclear Medicine: The Requisites, Third Edition (Requisites in Radiology)

Why do we get a false negative result?

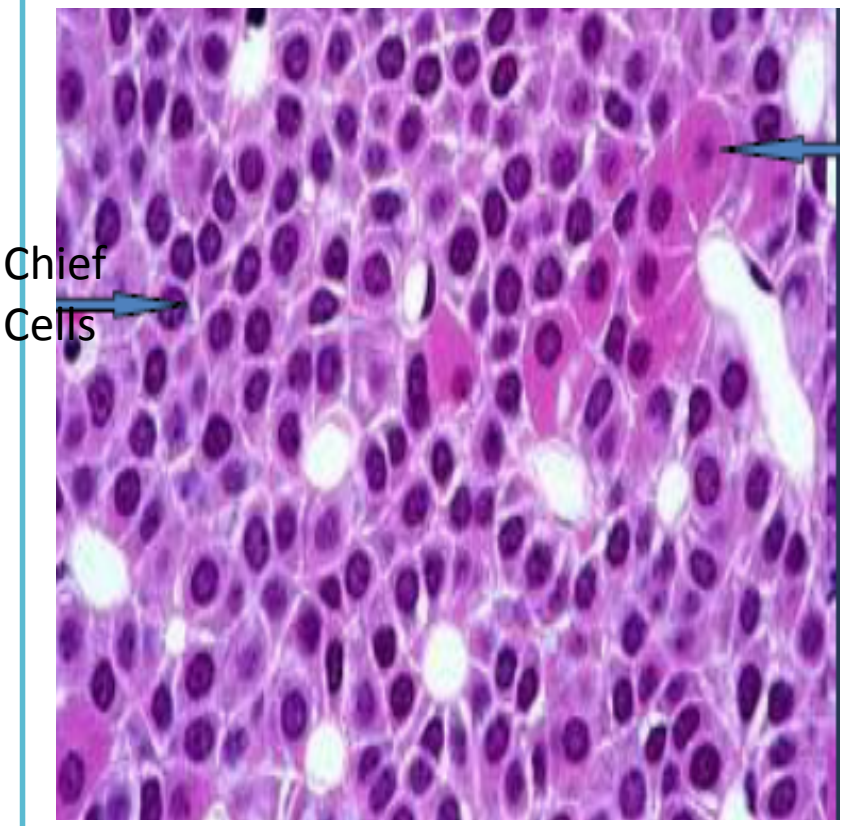
The parathyroid composed mainly of chief cells and oxyphilic cells.

If the parathyroid adenoma is composed of oxyphilic cells it will be obvious in the scan.

But, if the adenoma is composed of chief cells it will not show on the scan. Because the sestamibi is taken up by the oxyphilic cells only.

Parathyroid Cells

- Normal parathyroid glands comprise 2 cell types:
  - i. Chief cells: responsible for PTH production
  - ii. Oxyphil cells: eosinophilic cells whose cytoplasm is composed almost entirely of mitochondria.
- *While the normal oxyphil cell does not synthesize and secrete PTH, the oxyphil cells of pathologic parathyroid glands do secrete the hormone.*



Mechanism of Sestamibi uptake

- Its parathyroid uptake was first reported by Coakley et al. in 1989
- Mechanism of MIBI uptake and retention is still unclear. Multifactors have been proposed:

a. Biochemical properties of the tracer :

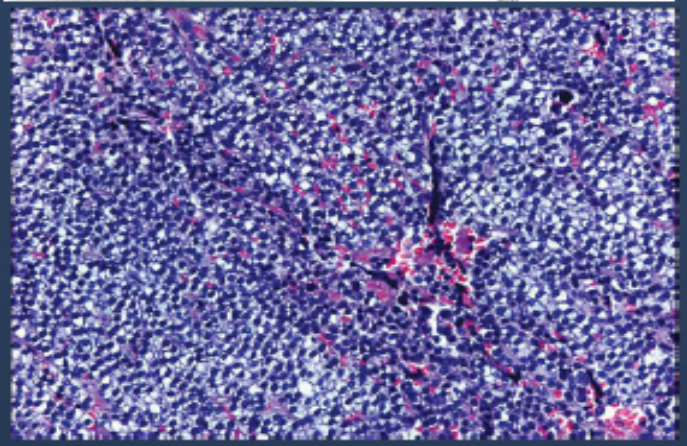
- Lipophilicity : The lipophilic sestamibi molecule is concentrated by mitochondria. This explains why adenomas with an abundance of mitochondrial-rich oxyphil cells retain the sestamibi

– Cationic charge

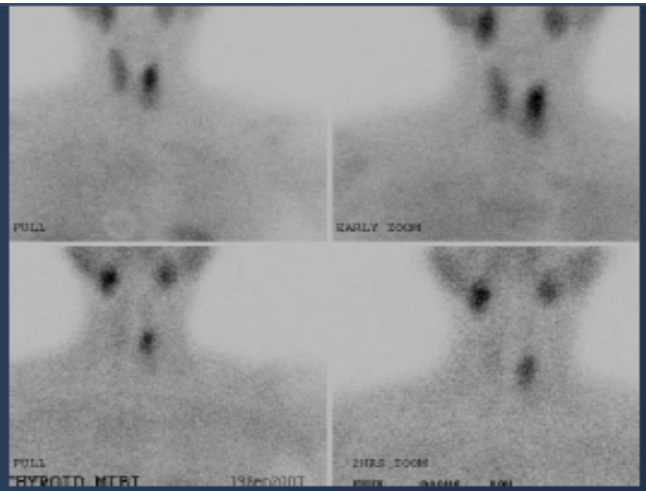
b. Cell Type: A predominance of oxyphil cells within an adenoma is more likely to lead to a positive scan.

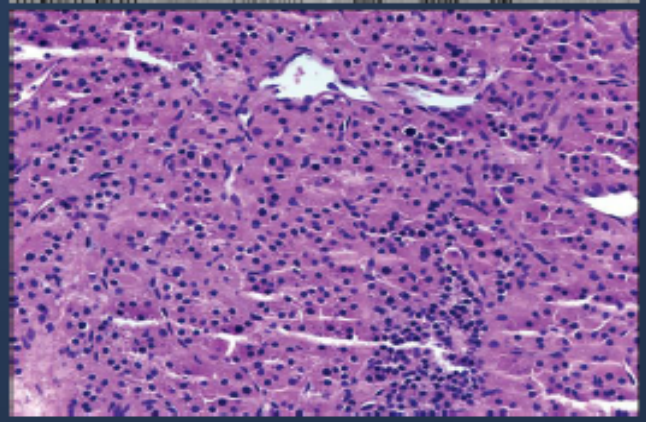
c. Local factors: blood flow, trans-capillary exchange, interstitial transport and negative intracellular charge of both mitochondria and membranes.

Cell Type and Scan Result



Parathyroid adenoma composed entirely of glycogen-rich chief cells.





Parathyroid adenoma composed mainly of mitochondrial-rich oxyphil cells.

Q : What is the cause of the False Negative? “FN” Sestamibi Scan…?

- **Histologic type:** False-negative scans can occur with parathyroid glands containing predominantly clear cells.
- **Size and Location:** Smaller-volume parathyroid adenomas and those in the upper position are less likely to be localized with sestamibi scans.
- **Number of adenomas:** FN rate is increased with MGD compared with patients with a single adenoma .
- **Decreased tracer concentration:** Possible association.
  a. P-glycoprotein expression
  b. Multidrug resistance–related protein expression
- **Variability of radiotracer uptake in parathyroid adenomas:** Related to differences in perfusion and metabolic activity

Even with refinements in sestamibi scanning, the fact that all parathyroid adenomas are not created equal on a cellular level may inevitably lead to FN scans in a certain number of cases

False-Positive Scintigraphic Findings

- Solitary thyroid adenoma or a multinodular goiter
- Benign or malignant tumors : breast, lung, and head and neck carcinomas and their lymph node and osseous metastases, as well as bronchial carcinoids.
- Primary thyroid lymphomas.
- Cervical L.N. metastasis from PTC carcinoma
- Reactive lymph nodes
- Remnant thymus
- PTH-secreting paraganglioma
- Enlarged submandibular salivary gland .

In the clinical setting of hyperparathyroidism, false-positive findings are uncommon.

Points To Remember Before Proceeding For Parathyroid Imaging

- Imaging is not for diagnosis: High Ca and PTH establish the diagnosis
- Imaging does not identify normal parathyroids: These are too small to be seen (20-30mg)
- Imaging should detect abnormal parathyroid(s) and indicate the approximate size and the precise relationship to the thyroid gland: lateral , SPECT and SPECT /CT
- Imaging should identify ectopic glands : SPECT and SPECT/ CT
- Optimal imaging should be able to differentiate patients with single adenoma from those with MGD
- Imaging should identify thyroid nodules which may require concurrent surgical resection.

Done

Thank you