

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

NUCLEAR MEDICINE in ENDOCRINOLOGY

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Nuclear physician

1401.10.13

NUCLEAR MEDICINE in Endocrinology

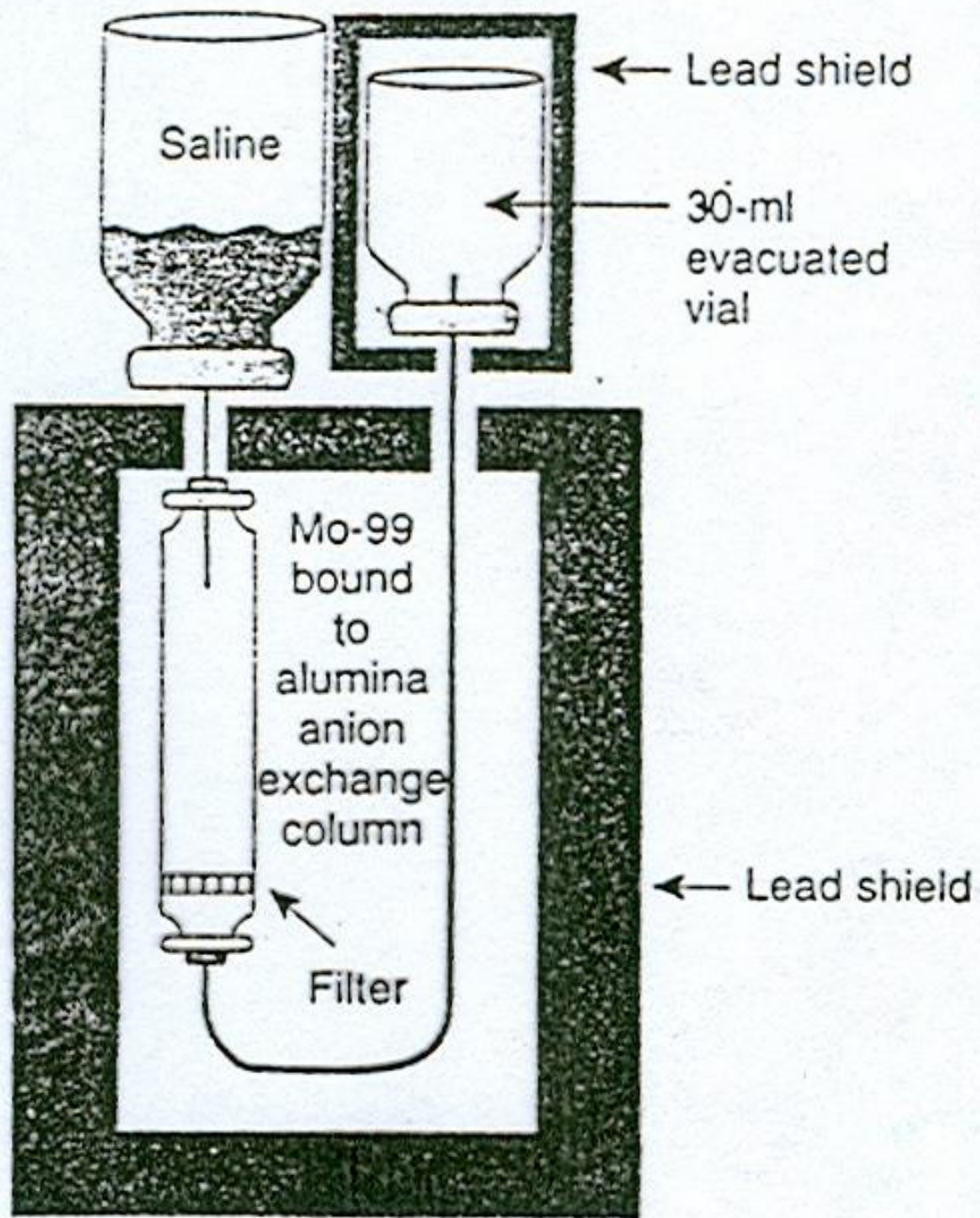
- Diagnostic
- Therapeutic

Scanning Techniques & Devices

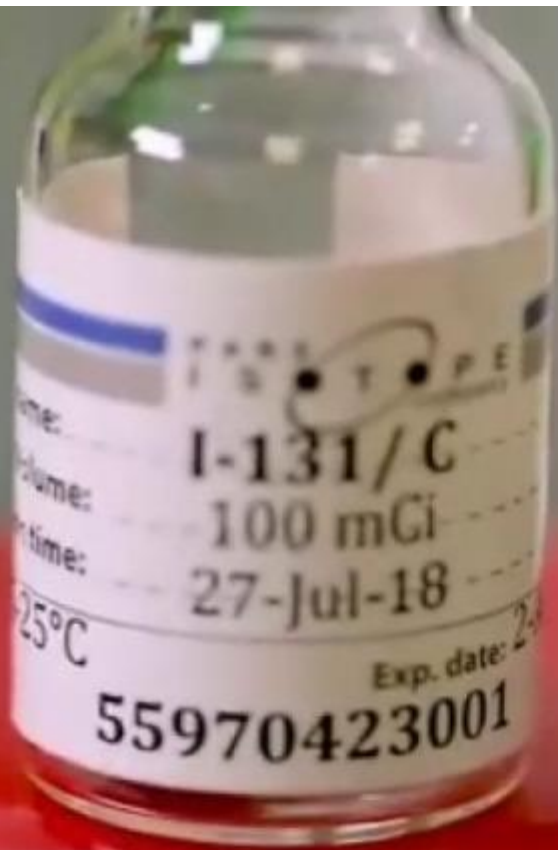


Scanning Techniques & Devices





RADIONUCLIDE GENERATORS allow to separate chemically short-lived radioactive daughter nuclei with good characteristics for medical imaging from long-lived radioactive parent nuclei.



PARSISOTOPE
 I-131/C
 100 mCi
 27-Jul-18
 25°C
 Exp. date: 28
 55970423001

Nuclear medicine and pregnant patients...

- Most diagnostic procedures are done with short-lived radionuclides (such as technetium-99^m) that do not cause large fetal doses
- Often, fetal dose can be reduced through maternal hydration and encouraging voiding of urine
- Some radionuclides do cross the placenta and can pose fetal risks (such as iodine-131)

Warning

- Check BHCG Before 131 -Radioiodine administration even 1 microcurie (last 72 hours)
- Best time of administration is during normal mensuration cycle .

Recommendations for cessation of breast feeding

radiopharmaceutical	dose	Imaging procedure	Cessation time
123 I	200-400 microcuri	Thyroid scan	48 hrs
Tc-pertechnetate	5 mci	Thyroid scan	24 hrs
I-131	10micro and more	Thyroid scan and therapy	discontinue
Tc-DTPA	10-15mci	Renal scan	17 hrs
Tc-SC	5mci	Liver-spleen scan	15 hrs
Tc-MDP	15-25mci	Bone scan	17 hrs
Ga-67	6-10mci	Infection and tumor scan	4 wks
TL-201	3mci	Myocardial perfusion scan	3 wks

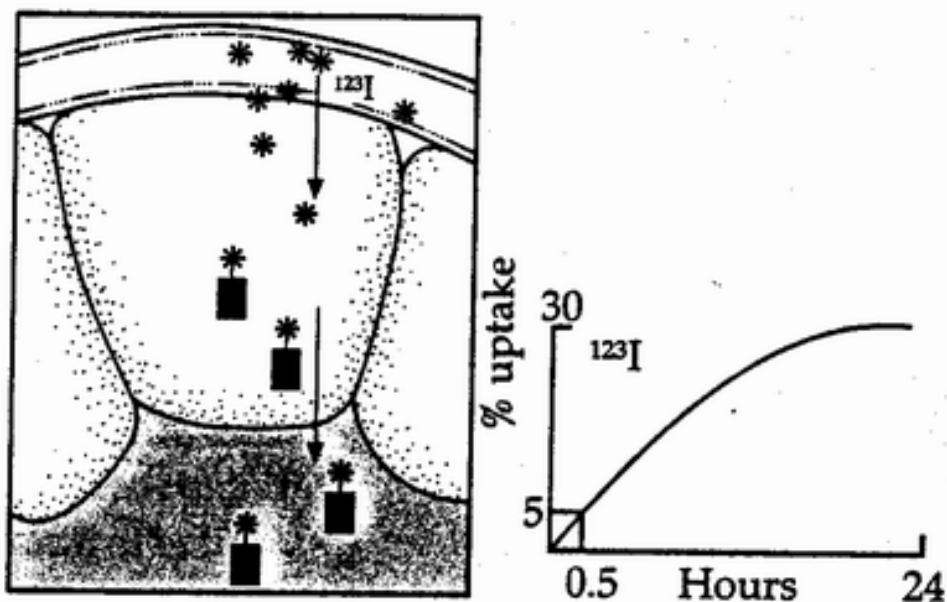
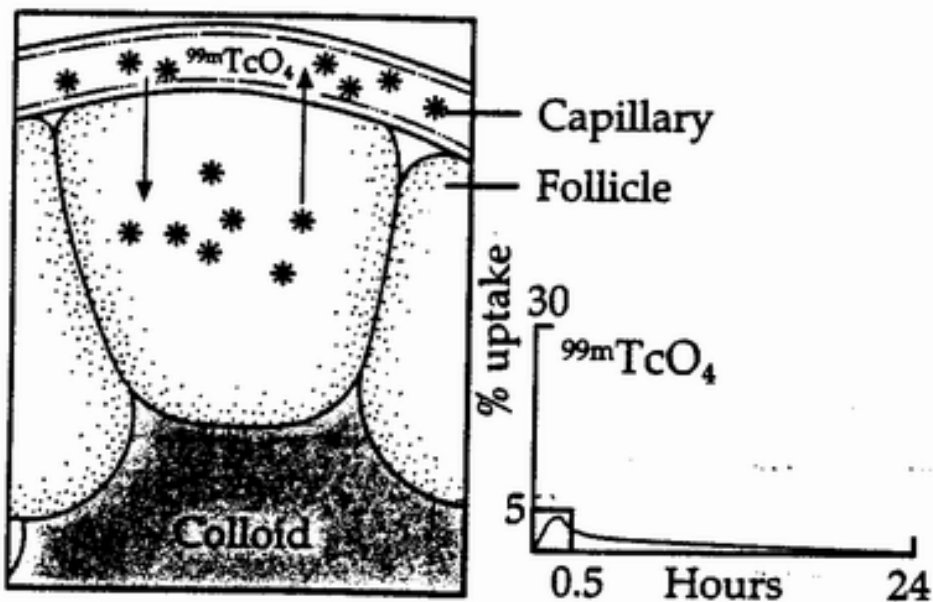
Radiopharmaceuticals

- Tc-99m pertechnetate
 - Trapped but non-organified – fast release
 - $E=140$ keV, $T/2=6$ hours
- I-123
 - Optimal for diagnosis – pure gamma emitter
 - $E=159$ keV, $T/2=13$ hours
- I-131
 - Used for therapy (beta radiation)
 - $E_{\text{gama}}=364$ keV, $T/2=8$ days

The thyroid

$^{99m}\text{TcO}_4$ is only trapped and not bound

Radioiodine is trapped and bound



Which one?

- **123-I:** The agent of choice for most adult thyroid imaging. Tc-99m pertechnetate is sometimes used in children because of its low radiation dosimetry and high count rate.
- **131-I:** is not the agent of choice for routine diagnostic scintigraphies (because of high energy emissions and the long half life).
- **Technetium-99m:** A frequently used alternative.

Thyroid scintigraphy

Advantages of Thyroid Scintigram over other Imaging Techniques

- **Allowing correlation of physical exam and anatomical imaging findings with physiology.**

PATIENT PREPARATION

Need to cease anti thyroid drugs or thyroxine replacement prior to scanning - (in consultation with the referring doctor).

DECREASED UPTAKE

➤ **Thyroid Hormones**

- Thyroxine (T4) 4–6 weeks
- Triiodothyronine (T3) 2 weeks

➤ **Excess Iodine (Expanded Iodine Pool)**

- Saturated solution of potassium iodide 2–4 weeks
- Some mineral supplements, cough medicines, and vitamin preparations 2–4 weeks
- Iodine food supplements
- Iodinated drugs (e.g., amiodarone) Weeks to months
- Iodinated skin ointments 2–4 weeks
- Congestive heart failure
- Renal failure

DECREASED UPTAKE

➤ Radiographic Contrast Media

- Water-soluble intravascular media 2–4 weeks
- Oral cholecystographic agents 4 weeks to indefinite
- Fat-soluble media (lymphography) Months to years

➤ Noniodine-Containing Drugs Variable

- Adrenocorticotrophic hormone, adrenal steroids
- Monovalent anions (perchlorate)
- Penicillin
- Antithyroid drugs
- Propylthiouracil (PTU) 3–5 days
- Methimazole (Tapazole) 5–7 days
- Bromides

➤ Goitrogenic foods (e.g., cabbage, turnips)

➤ Prior radiation to neck

INCREASED UPTAKE

Iodine Deficiency

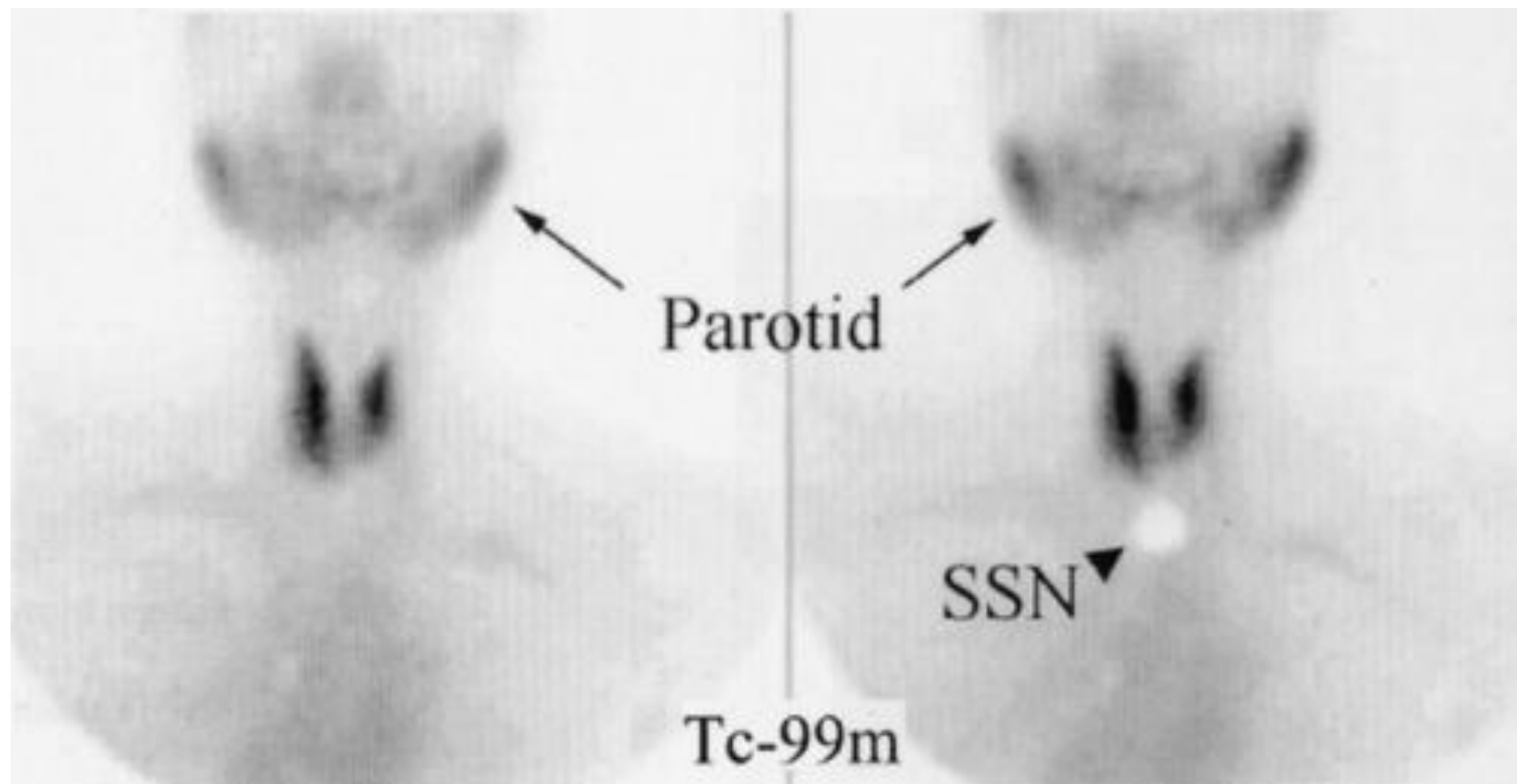
Pregnancy

Rebound after therapy withdrawal (thyroid hormones, antithyroid drugs)

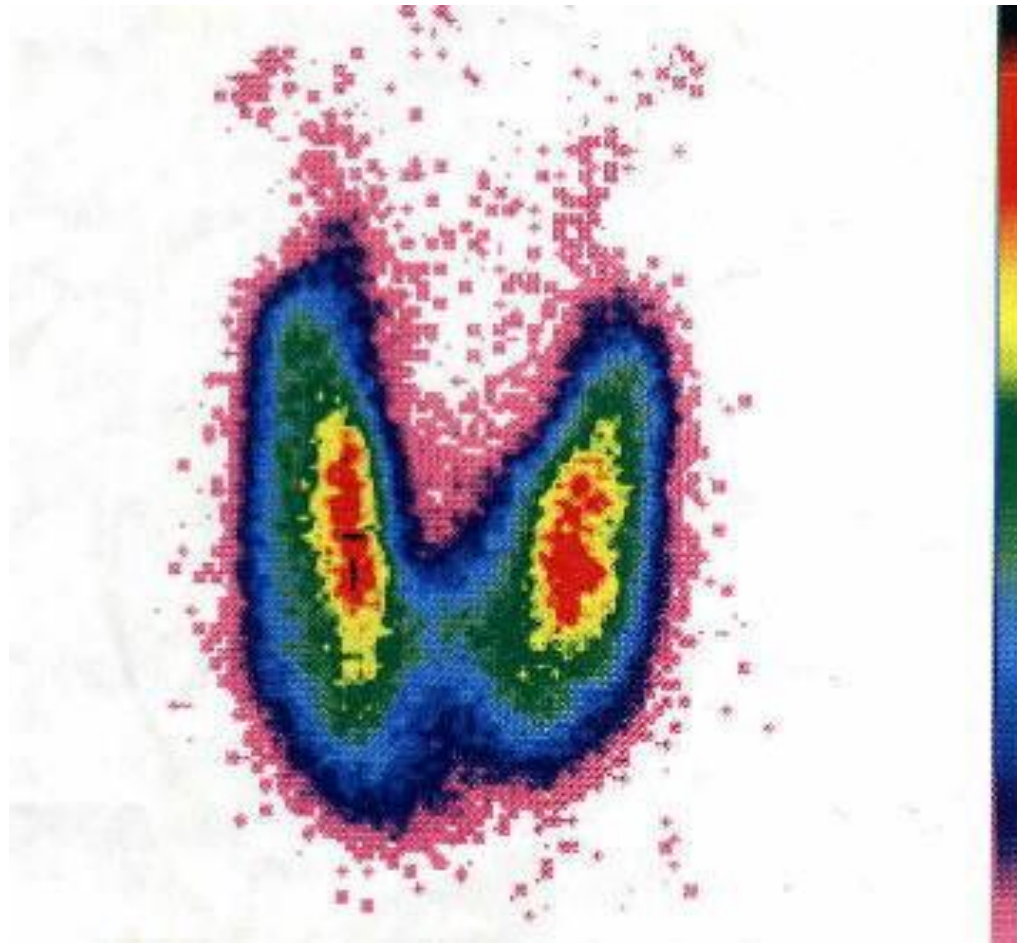
Lithium

Physical Characteristics of Tc-99m

- Half life: 6 hr
- Generator produced
- Usual dose: 3-10 millicurie



Normal Thyroid Scintigram



Normal Thyroid Scintigram



Thyroid Uptake = 13.6%

Normal Uptake Range = 0.5 - 3.5%

Scintigraphy in Evaluation of Thyroid Nodules

- Can not be used to exclude or confirm the malignancy.
- FNA with Scintigraphy is a more direct means base on sonographic TI-RADS findings.
- Hot or Cold (Radioiodine Therapy)

COLD NODULES (NONFUNCTIONING)

Benign

- Colloid nodule
- Simple cyst
- Hemorrhagic cyst
- Adenoma
- Thyroiditis
- Abscess
- Parathyroid cyst or adenoma

Malignant

- Papillary
- Follicular
 - Hurthle cell
- Anaplastic
- Medullary
- Lymphoma
- Metastatic carcinoma
 - Lung
 - Breast
 - Melanoma
 - Gastrointestinal
 - Renal

HOT NODULES (AUTONOMOUS FUNCTION)

Toxic follicular adenomas

WARM NODULES

- Nontoxic hyperfunctioning adenomas
- Hyperplastic thyroid tissue

Scintigraphic classification of thyroid nodules

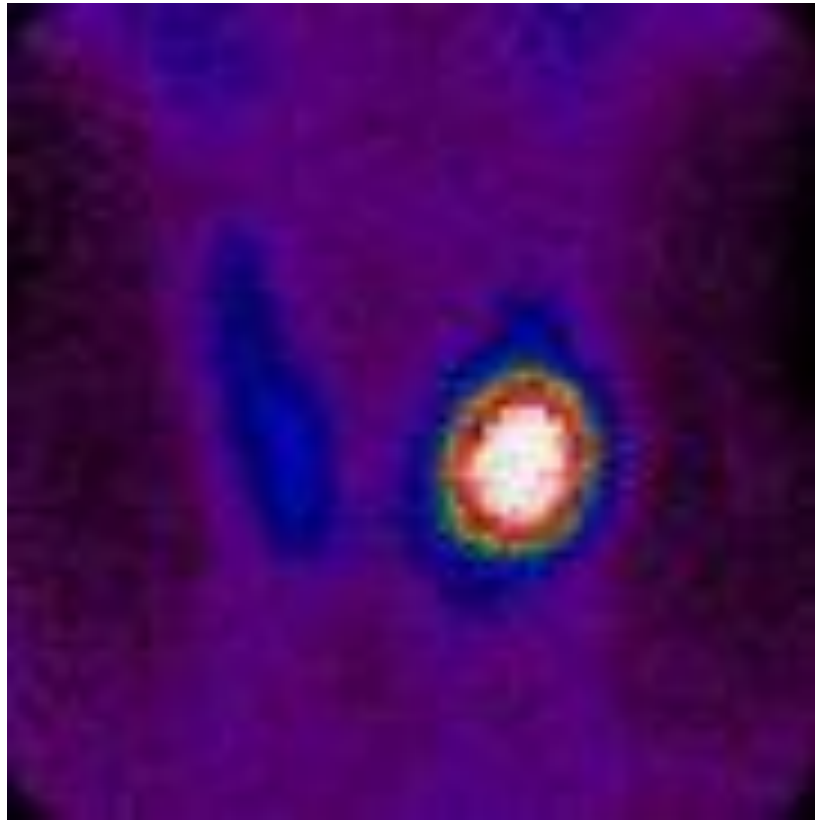
● Cold (Hypofunctioning)

● Hot (Functioning)

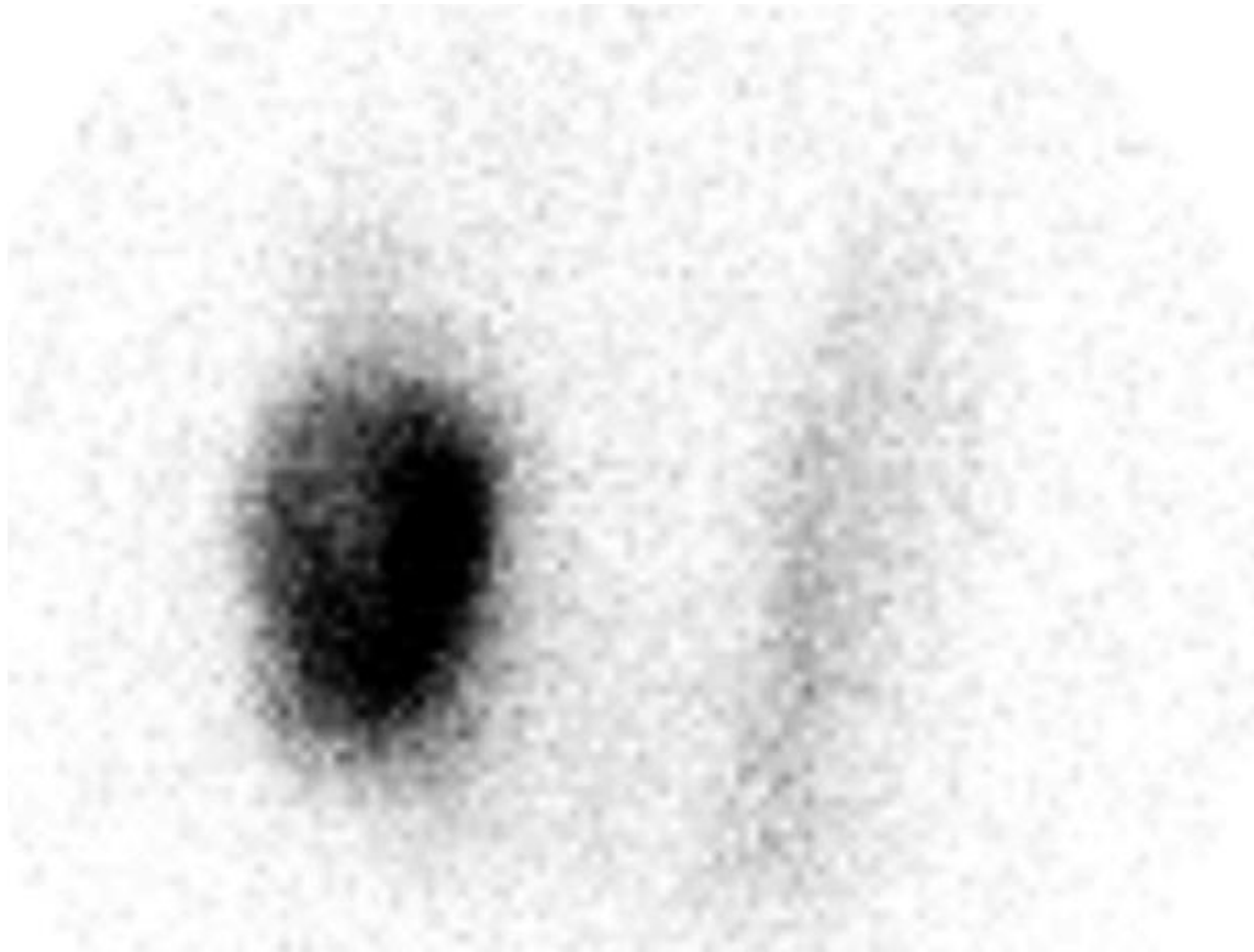
● Warm

● Indeterminate: Function equals to that of surrounding normal thyroid

A hot Thyroid Nodule



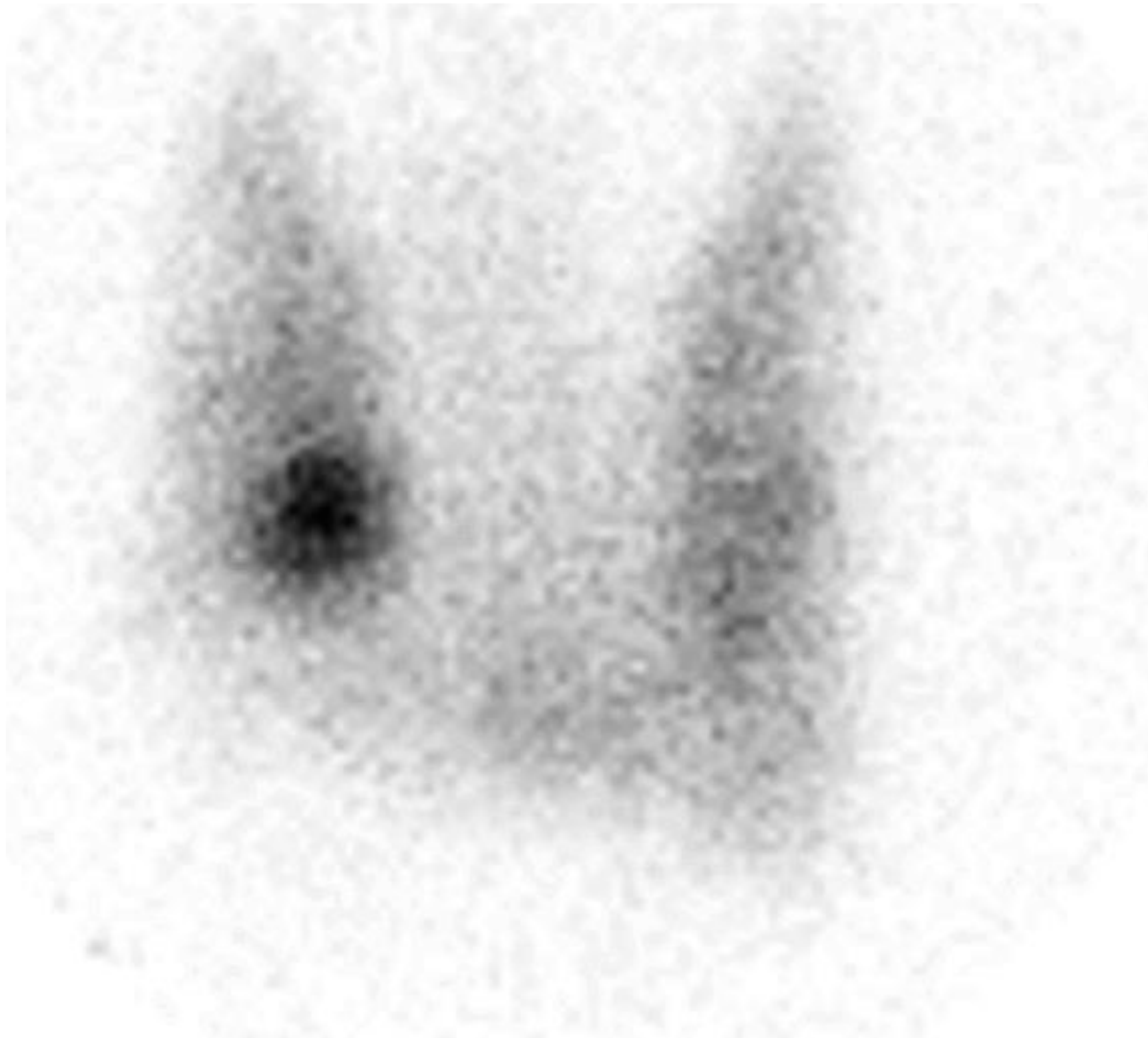
A hot Thyroid Nodule



A Warm Thyroid Nodule



Warm nodule in euthyroid patient



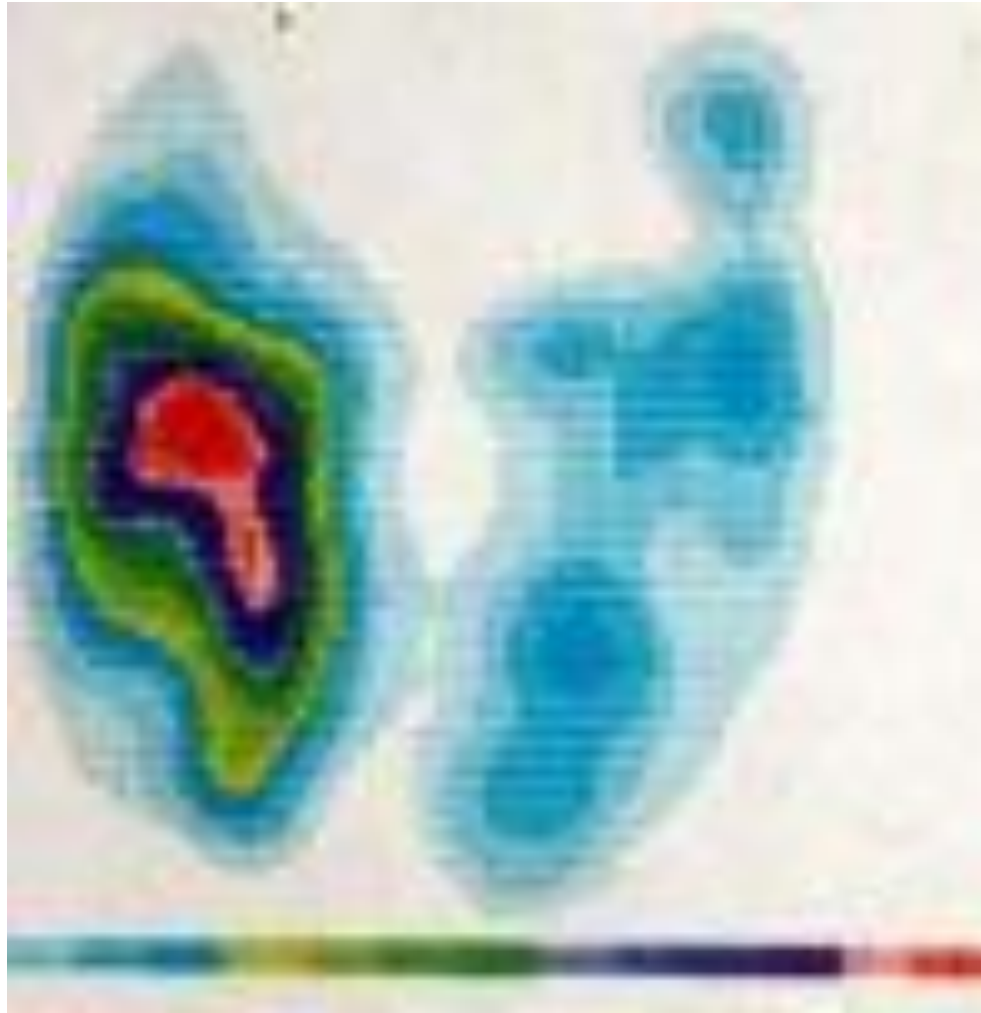
Warm nodule in euthyroid patient

- Patient presented with a palpable 1.5-cm nodule.
- Increased uptake is seen in the inferior aspect of the right lobe of the thyroid. The extranodular gland does not appear to be suppressed.
- The patient had normal thyroid function tests.

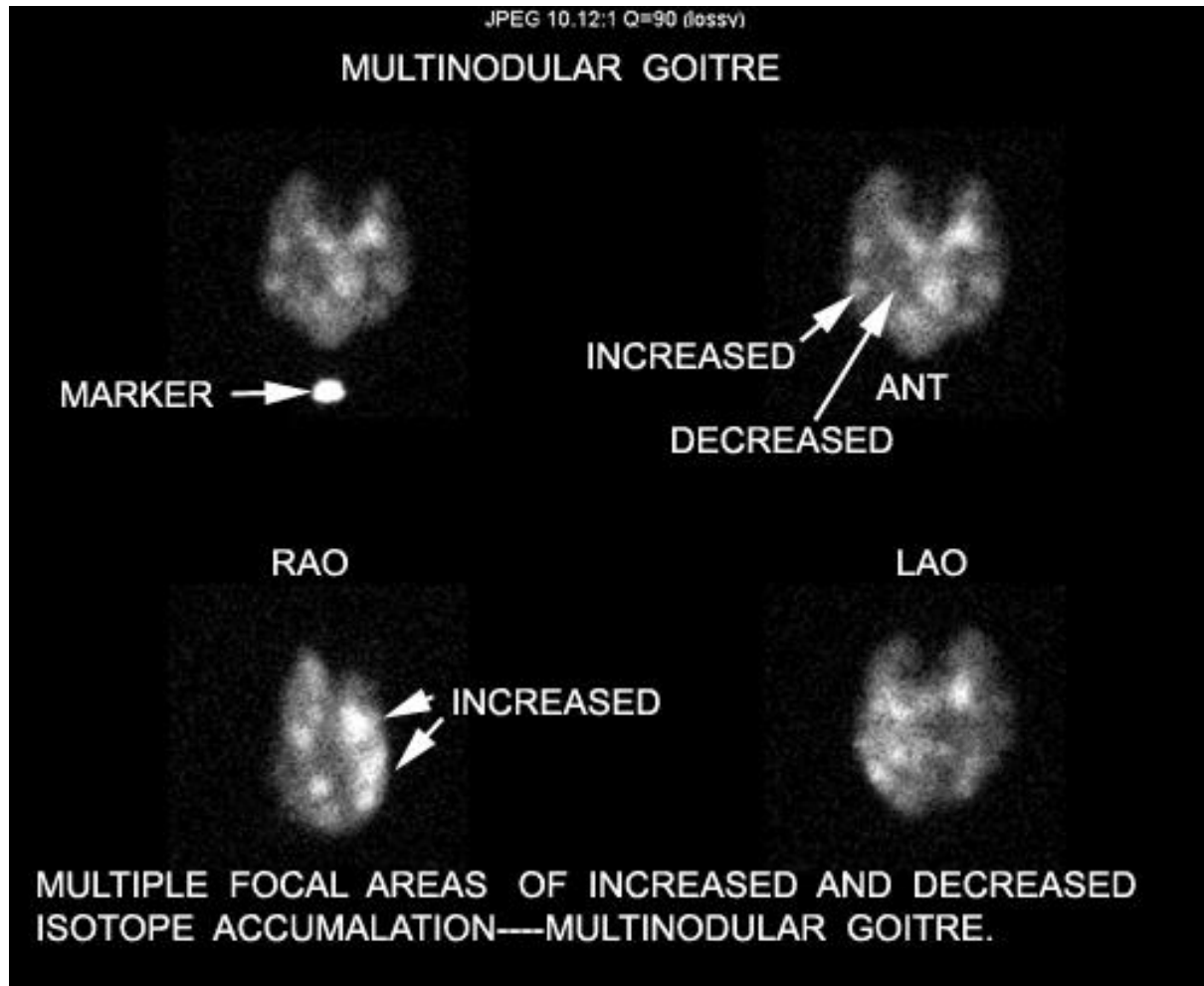
Thyroid Nodules (continue)

- Nonfunctioning nodules appear cold and require further evaluation by FNA?.
- Autonomously functioning nodules may appear hot . Only a few patients with autonomous nodules have been found to have thyroid cancer , and only a few of these cancers were aggressive .
- Furthermore, in some of these patients, the cancer was adjacent to the autonomous nodule rather than within it.

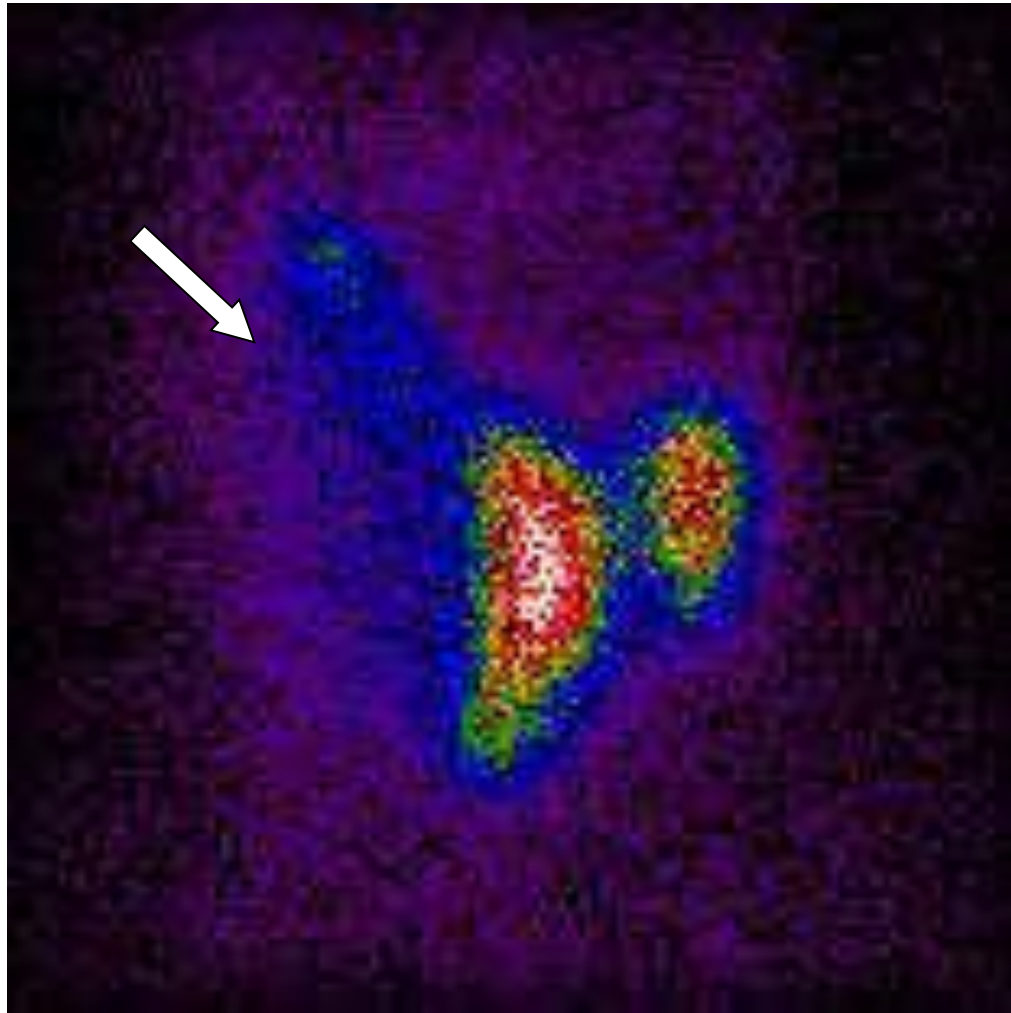
Multinodular Goiter



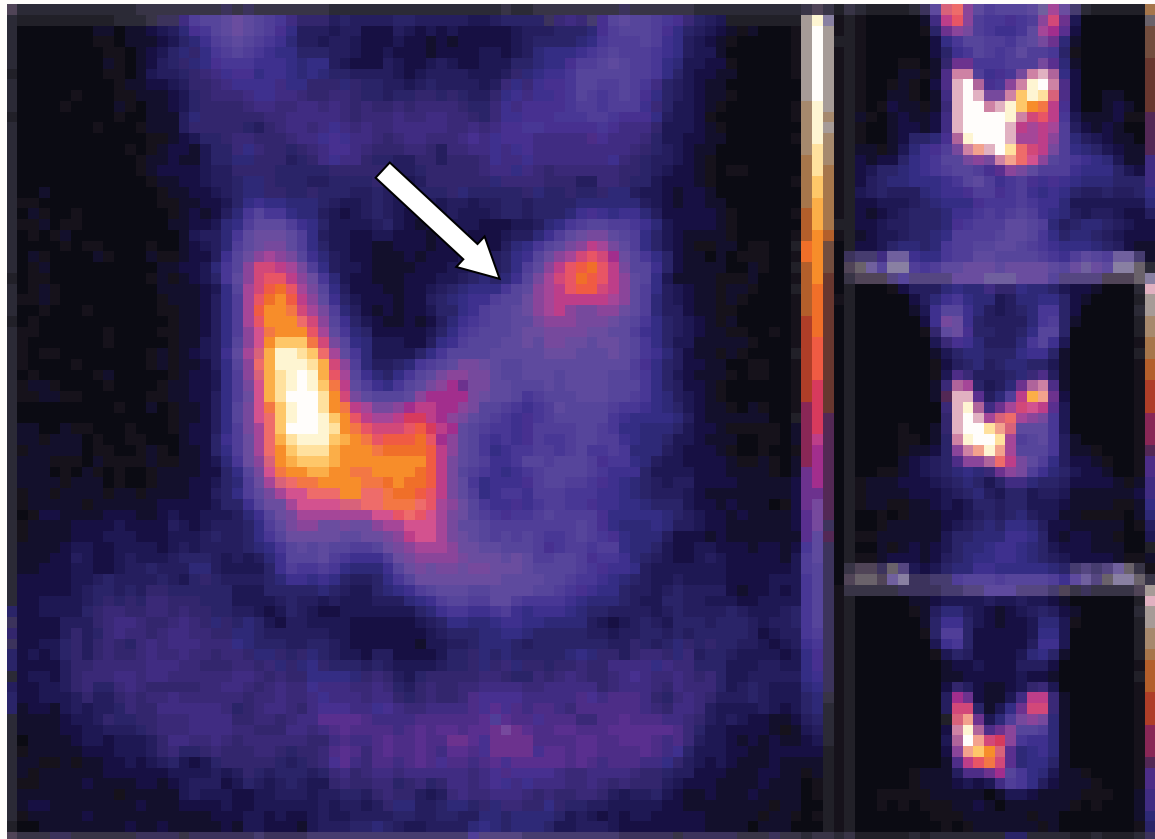
Multinodular Goiter



Cold Nodule



Cold Nodule

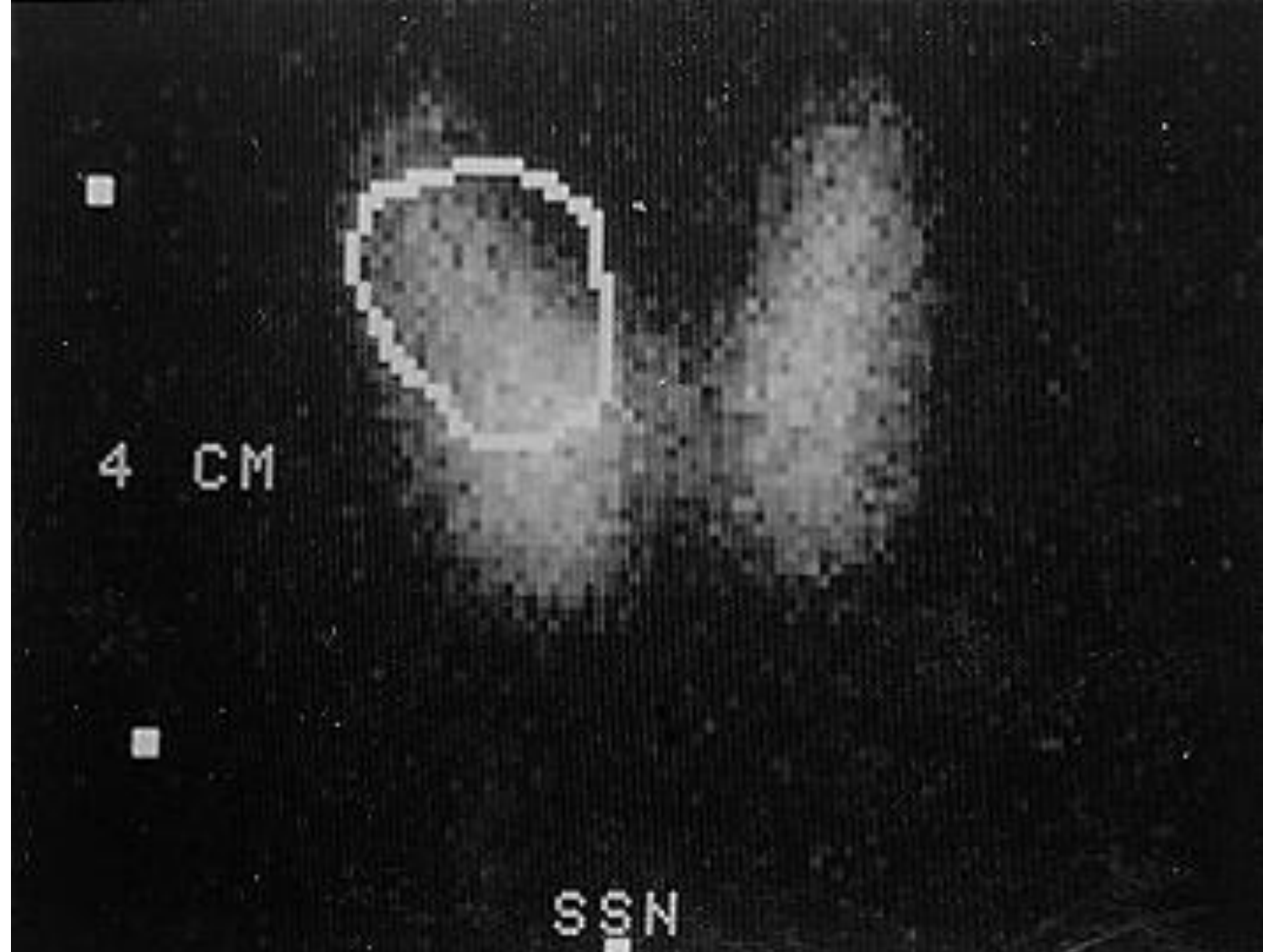


Indeterminate Nodule

- When a palpable or sonographically detected nodule greater than 1 cm cannot be differentiated by thyroid scan as definitely hot or cold compared to surrounding normal thyroid, it is referred to as an *indeterminate nodule*

Indeterminate Nodule

- Nodules less than 1 cm may be too small to be detected by scintigraphy.
- For management purposes, an indeterminate nodule has the same significance as a cold nodule.



Indeterminate thyroid scan ^{123}I thyroid scan of a 2 cm papillary cancer, which does not appear as a nonfunctioning nodule because it overlies normal isotope concentration in the uninvolvement portion of the right lobe. SSN = suprasternal notch. Courtesy of Douglas Ross, MD.

Discordant Nodule

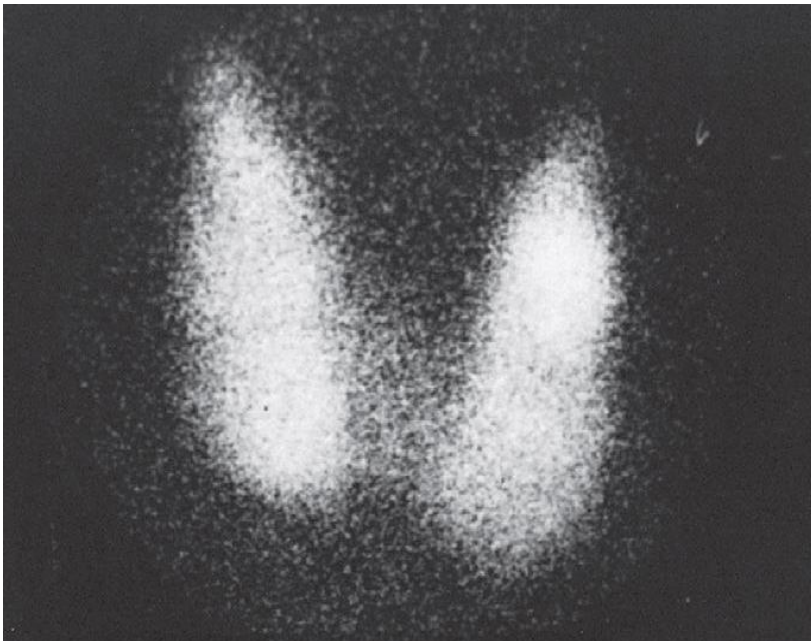
- Some apparently hot or warm nodules on Tc-99m scans appear cold on radioiodine scans.
- This occurs in only 5% of patients.
- Because some thyroid cancers maintain trapping but not organification.
- A single hot nodule identified on Tc-99m imaging should not be considered a functioning nodule until confirmed by I-123 scan.

Discordant Nodule

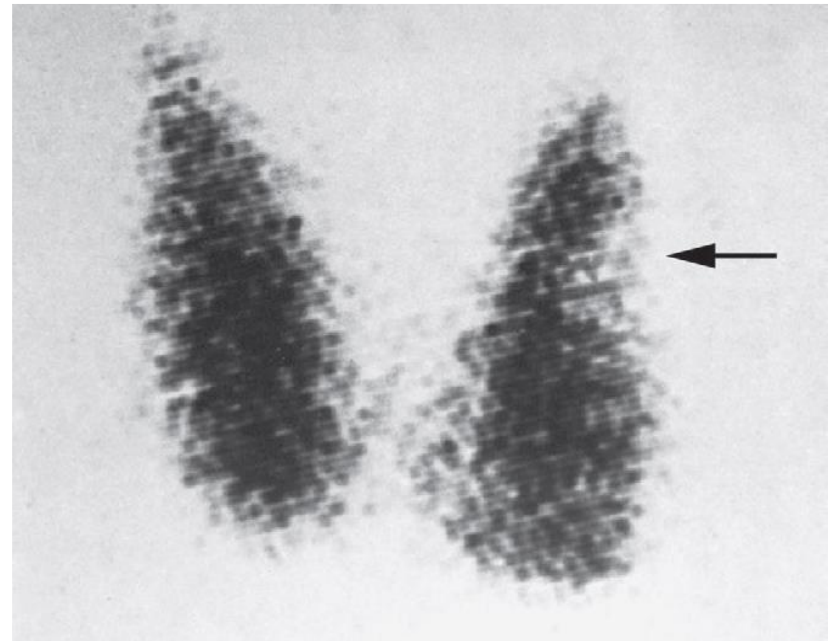
- The discordant nodule is a disadvantage to the use of Tc-99m pertechnetate for evaluation of thyroid nodules.
- Of discordant nodules, 20% are malignant.

Discordant Nodule

TC scan



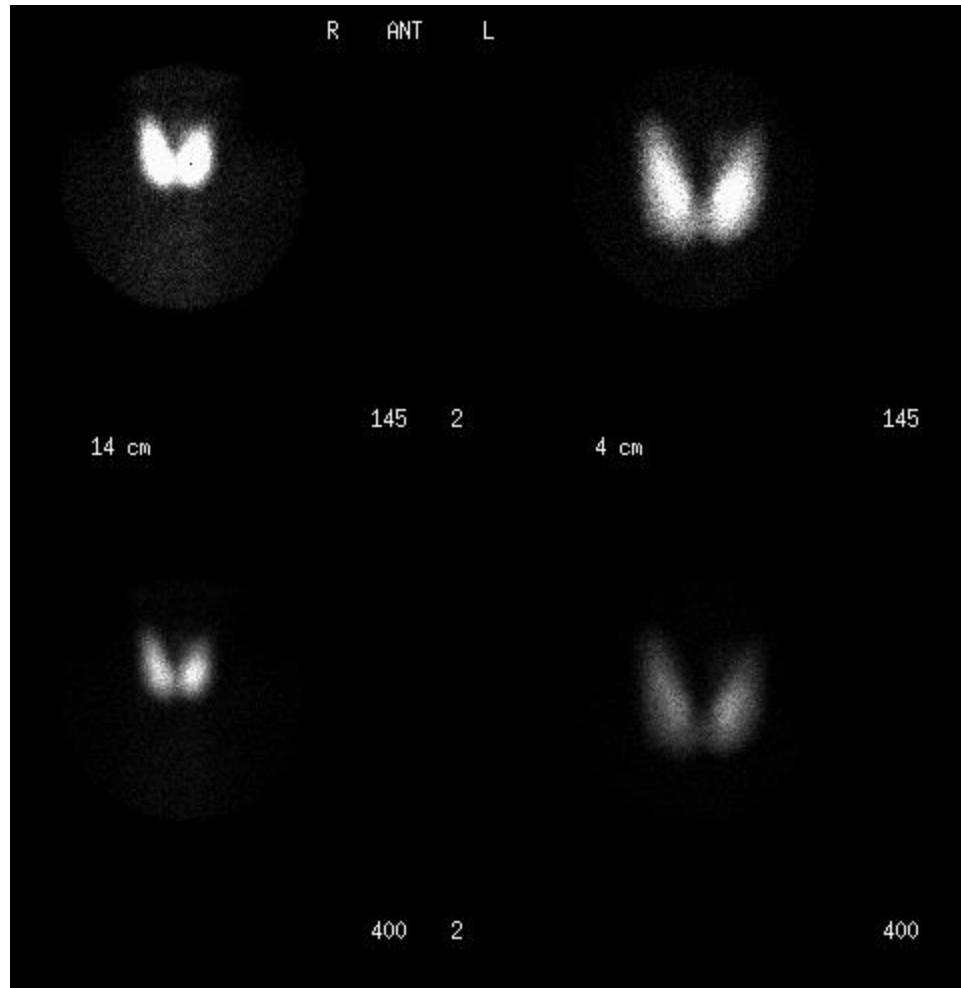
^{123}I scan



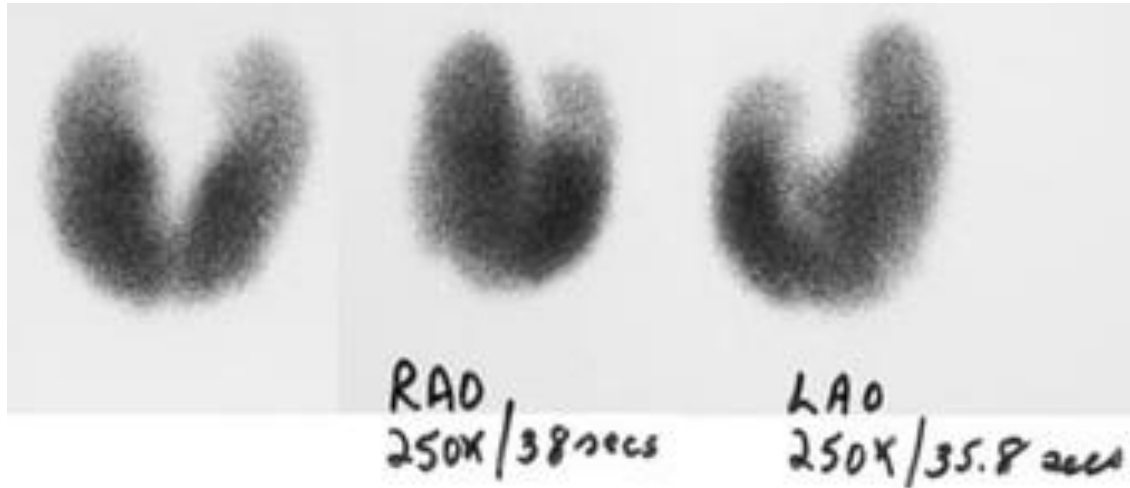
Differential Diagnosis of thyrotoxicosis

- Grave's Disease
- Toxic Multinodular goiter
- Toxic Adenoma
- Thyroiditis
- Thyrotoxicosis Factitia

Grave's Disease



Grave's Disease





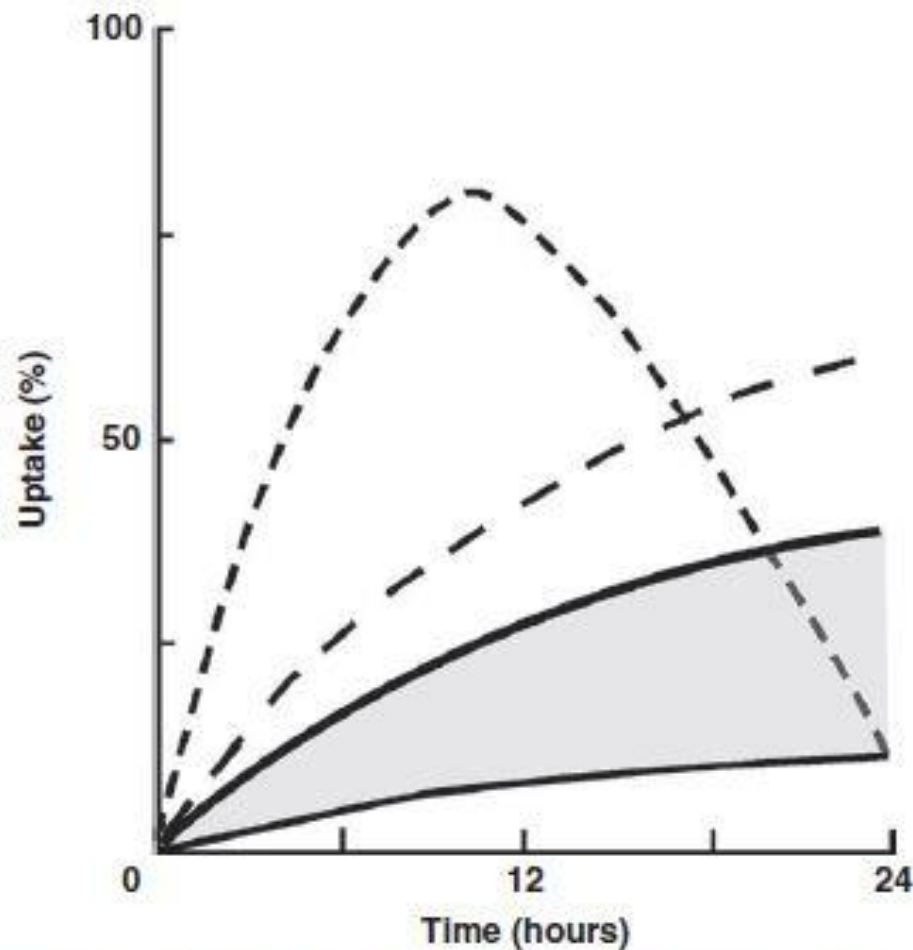


FIGURE 6-4. Radioiodine uptake after oral administration. In normal subjects the percent radioactive iodine thyroid uptake (%RAIU) increases progressively over 24 hours to values of 10% to 30% (*gray area*). With Graves disease, the %RAIU rises at a more rapid rate to higher levels, often 50% to 80% and greater (*lower broken line*). However, some patients with Graves disease have rapid iodine turnover within the thyroid with early, rapid, high uptake at 4 to 12 hours, but returning to a mildly elevated or even normal uptake by 24 hours (*top broken line*).

Hashimoto disease

- Scintigraphic findings are variable. Uptake may be inhomogeneous throughout the gland, or focal cold areas without a palpable nodule may be present.

Hashitoxicosis

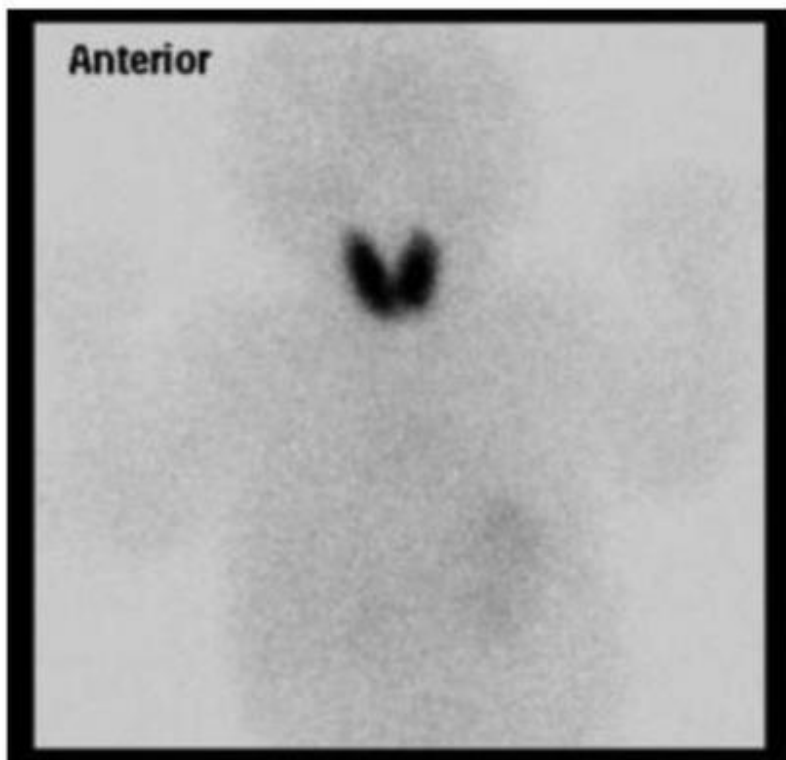
- Approximately 3% to 5% of patients with Hashimoto disease develop thyrotoxicosis, or **hashitoxicosis**, at some point during the course of the disease.
- During the thyrotoxic phase, the %RAIU is increased and the scan shows diffuse increased uptake, similar to Graves disease.

Hashimoto Hypothyroidism

- Elevated TSH in early stage of Hashimoto's thyroid tissue destruction may show globally increased activity of thyroid gland.

Dyshormonogenesis

A



B



Radioactive Iodine Uptake Test (RAIU)

- Useful assessment of thyroid function
- The higher the iodine uptake, the more active the gland
- Normal 24 hour RAIU = 8 to 35% (5 to 30%)
- Normal 4 hour RAIU = 5 to 15%

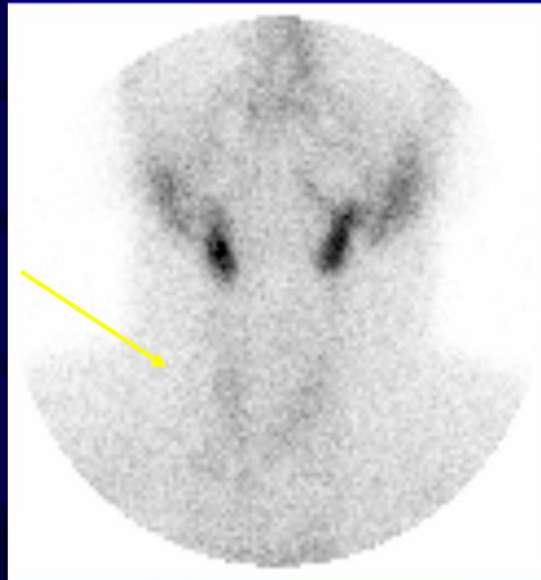
Indications

- To confirm hyperthyroidism
- To calculate therapeutic dose of I-131
- To determine the cause of thyrotoxicosis
 - ** high RAIU uptake in "true hyperthyroidism"
 - ** low RAIU in thyroiditis or who abuse thyroid hormones

Reduced RAIU

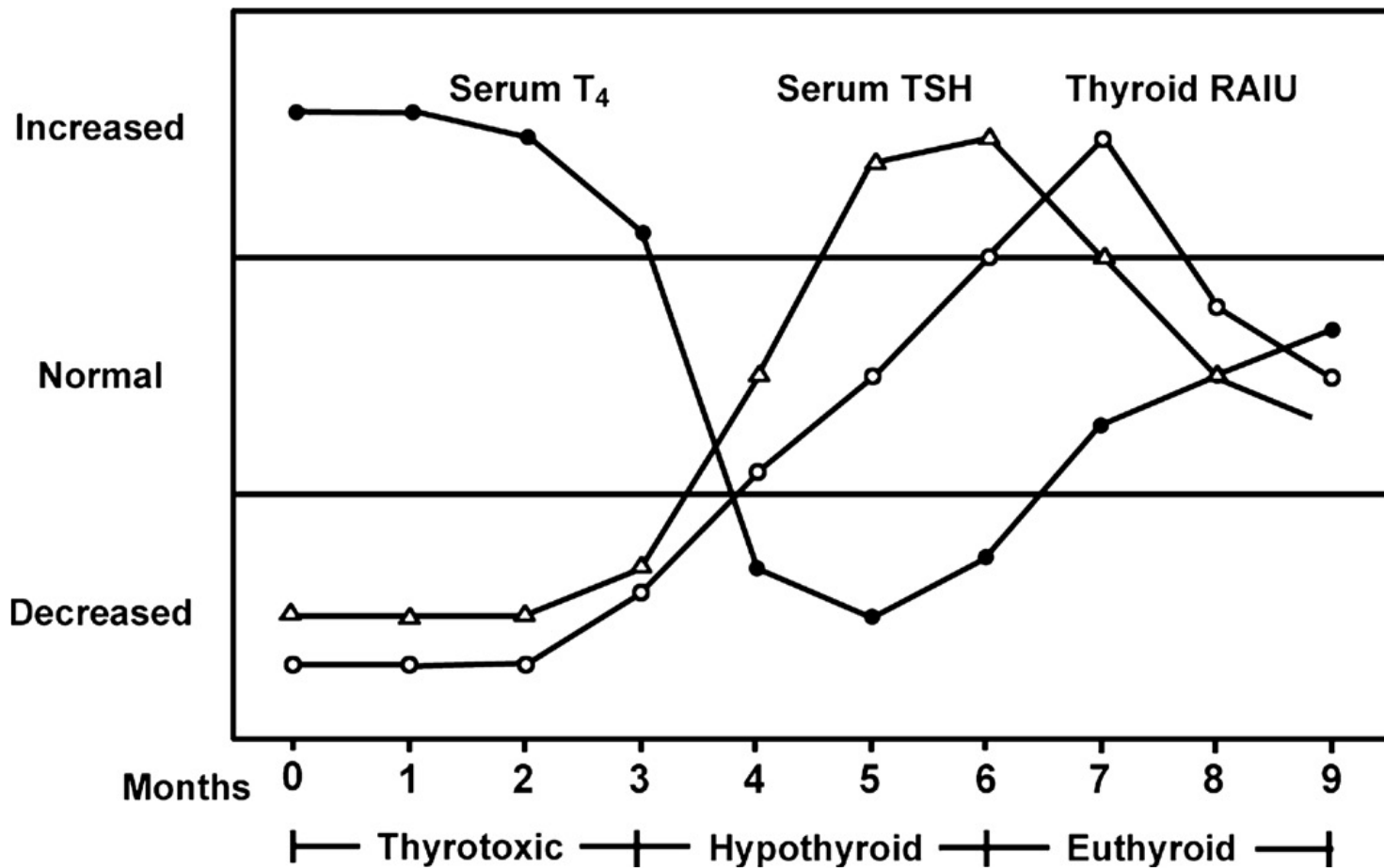
- *Granulomatous thyroiditis (de Quervain)*
- *Silent thyroiditis*
- *Postpartum thyroiditis*
- Iodine-induced thyrotoxicosis (Jod-Basedow)
- Amiodarone-induced thyrotoxicosis
- Thyrotoxicosis factitia
- Struma ovarii .

Subacute thyroiditis



Tc-99m pertechnetate

SAT



Amiodarone-Induced Thyrotoxicosis

- Type 1, which is iodine induced (Jod-Basedow) in patients with preexisting nodular goiter or subclinical Graves disease, the %RAIU is elevated.
- Type 2, which is more common, results in a destructive thyroiditis, and the %RAIU is near zero.

Amiodarone-Induced Thyrotoxicosis

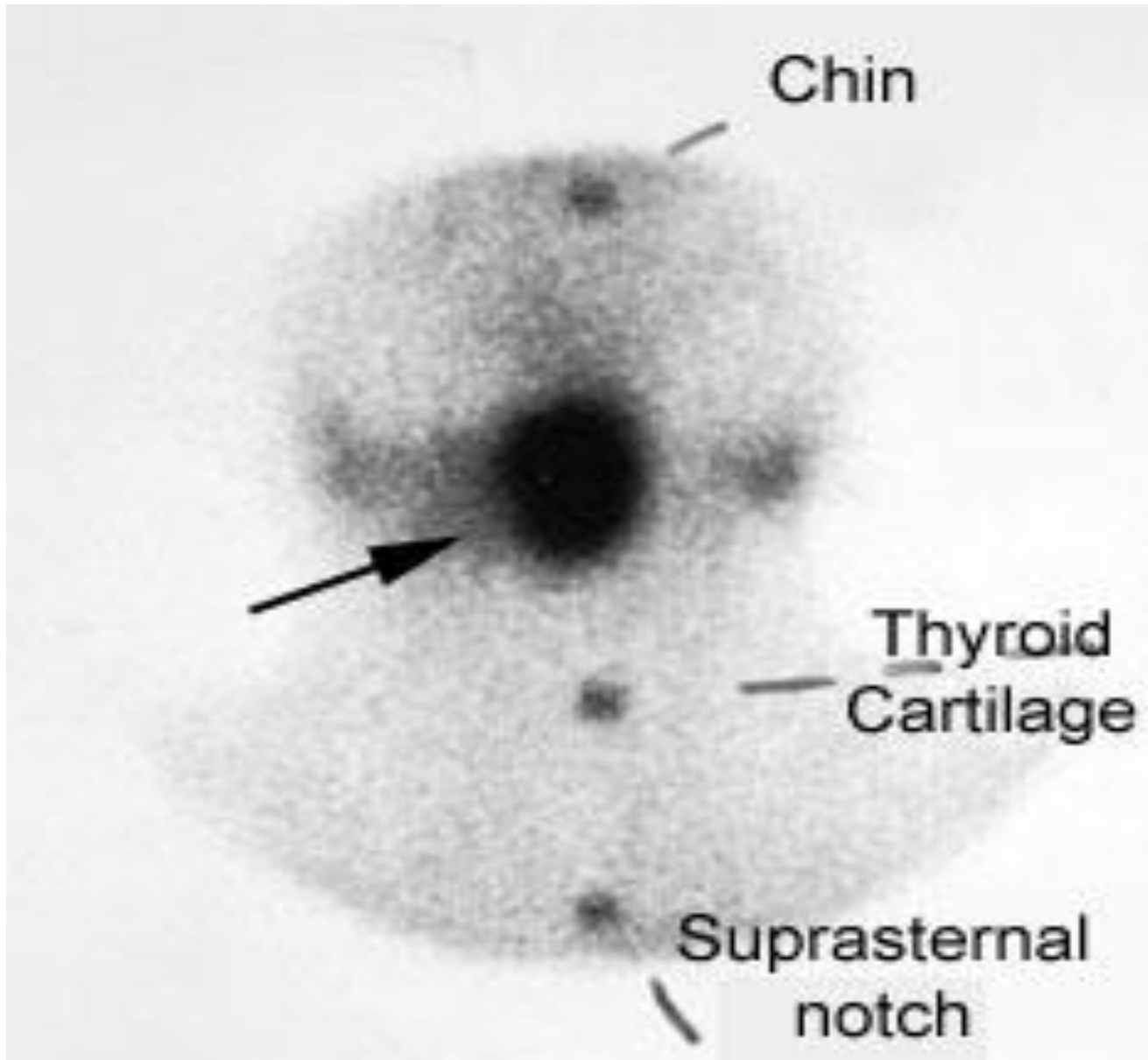
- The 24-hour radioiodine uptake is typically not able to distinguish between types I and II AIT, because the high levels of ingested iodine with amiodarone results in 24-hour uptakes of less than 1 percent in most patients with either type I or type II AIT.
- ^{99m}Tc-sestamibi imaging, where available, or color flow Doppler sonography (CFDS) may be the best ways of distinguishing between the two types of AIT.

- Two reports utilized technetium-99m (99mTc)-sestamibi thyroid uptake and scintigraphy to distinguish type I (normal or increased) from type II (decreased) and found this to be more useful than CFDS.

Ectopic Thyroid Tissue

- lingual, substernal, pelvic/ovarian teratoma (struma ovarii)
- Pertechnetate is not useful for imaging the substernal and pelvic area due to attenuation or superimposed blood pool activity.

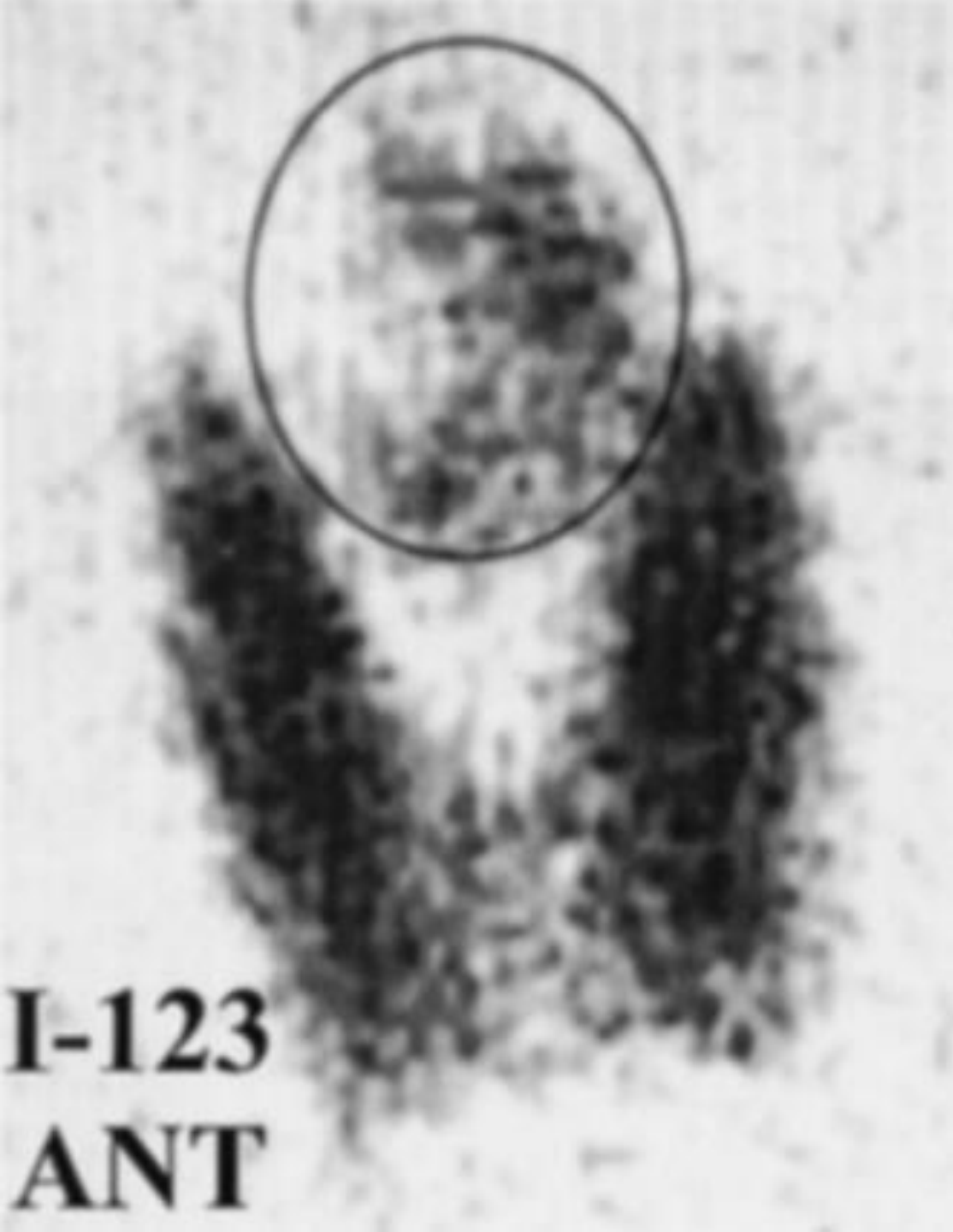




Thyroglossal duct cyst

- Midline along the migratory path of the embryologic gland, anywhere from the foramen cecum at the base of the tongue to the lower neck
- The vast majority of patients have normal thyroid scans.
- Complications: Infection, and rarely papillary thyroid carcinoma



A black and white micrograph showing a dark, elongated, V-shaped structure. A thin black circle highlights a specific region at the top of the structure. The background is light and grainy.

I-123
ANT

Physical Characteristics of I-131

- Half-life of 8.05 days
- Emits a high energy gamma (364 keV) and particulate emissions
- Reactor produced

Radioactive measurement Units

- $1 \text{ mCi} = 37 \text{ MBq}$

یک میلی کوری = 37 مگابکرل

- $1 \text{ Ci} = 37 \text{ GBq}$

Dose of I-131

Diagnostic

1. Retrosternal Goiter: 50-200 Microcurie
2. whole body scans for following of thyroid carcinoma: 2-7 mCi

Therapeutic

1. Non-neoplastic applications: 5-29 mCi
2. Differentiated thyroid CA: 30-200 mCi

I-131 Thyroid Scintigraphy:

- Evaluation of a substernal mass
- Detection of persistent residual tissue after thyroid surgery for DTC
- Detection of regional cervical lymph node involvement or distant metastatic involvement

Substernal Thyroid Masses

- I-131 is the preferred imaging agent due to mediastinal blood pool activity with Tc-99m and significant attenuation of low energy gamma photons by sternum
- Most intra-thoracic goiters demonstrate anatomic continuity, but not necessarily functional continuity with cervical thyroid tissue.

Multinodular Goiter with Retrosternal Extension



Radiotracer in Endocrinology

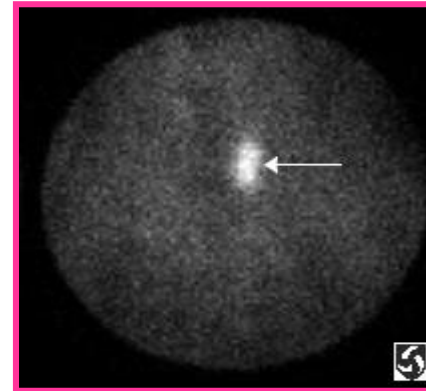
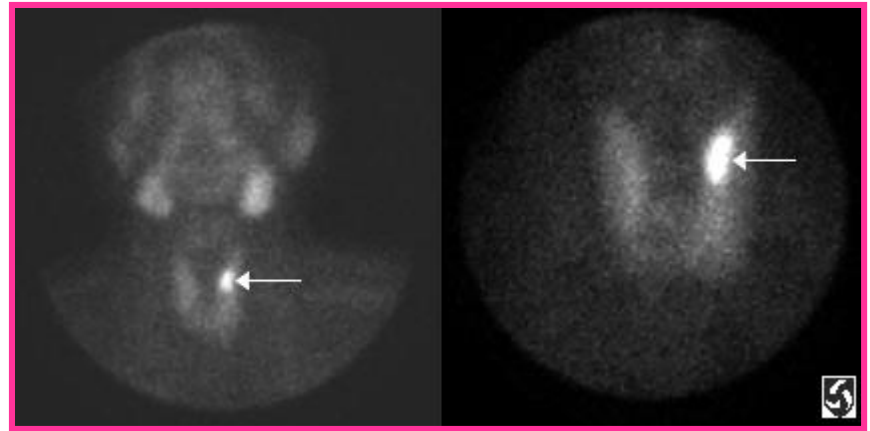
- ^{99m}Tc or pertechnetate: Thyroid scan
- ^{99m}Tc -MIBI: Sestamibi: Parathyroid adenoma , ...
- ^{99m}Tc -Octreotide: Octreoscan: NET
- ^{68}Ga -Dotatate: NET
- ^{131}I : Diagnosis and treatment
- ^{131}I -MIBG: Adrenal Medulla (pheochromocytoma)

Parathyroid adenoma Scintigraphy

- **^{99m}Tc -MIBI=Sestamibi**

- **25 mCi**

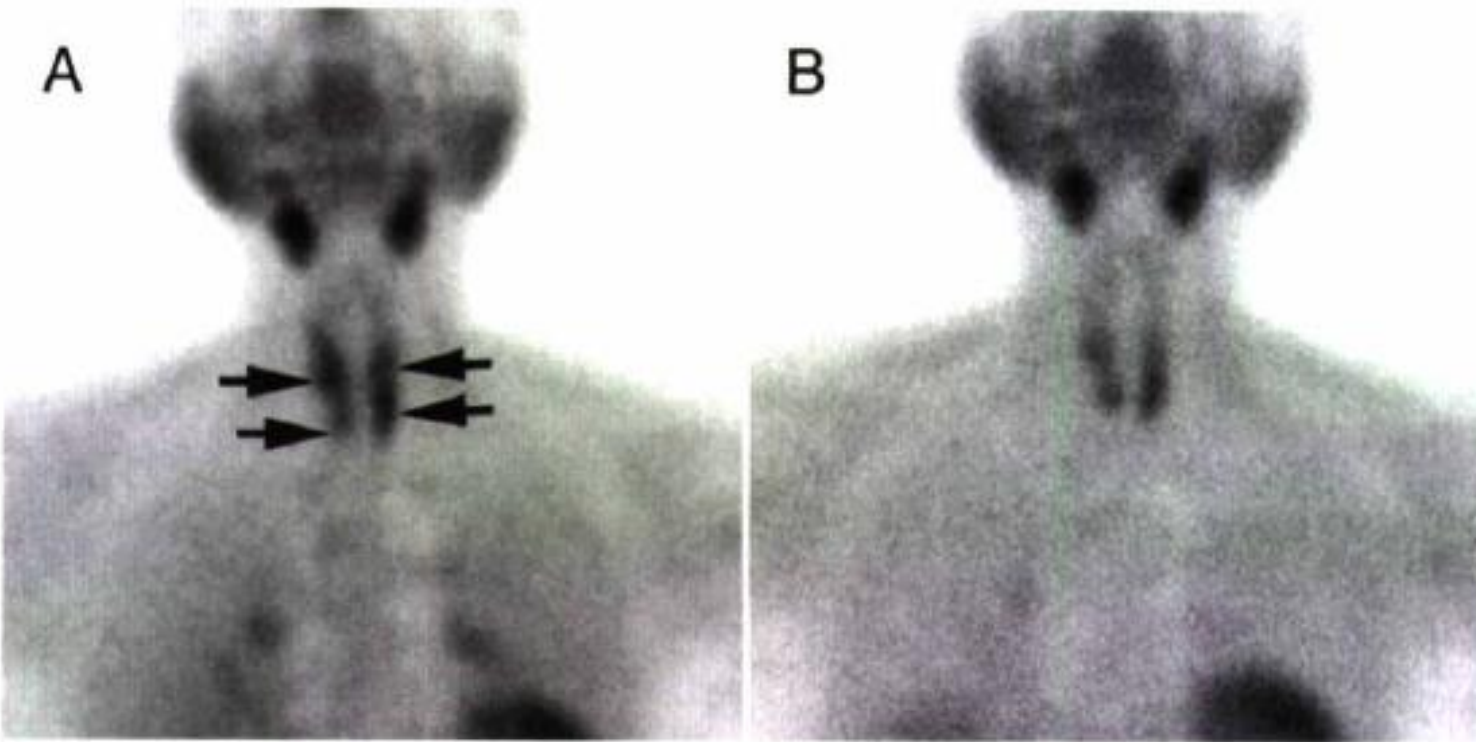
- ▶ Normal diffuse uptake by the thyroid gland.
- ▶ A focal area of increased tracer uptake is present in the medial aspect of the upper pole of the left thyroid lobe.
- ▶ Delayed images reveal washout of activity from the thyroid gland and persistent activity in the medial aspect of the upper pole of the left lobe.
- ▶ Diagnosis: Parathyroid adenoma.





r ant

Parathyroid hyperplasia



Sensitivity for hyperplastic tissue is less than 70% .

False negative finding

- Too small adenoma < 300mg or less than 1 cm
- Large adenoma > 1.5 gr
- Low oxyphilic cells
- Rapid washout

False Positive

- Cervical Reactive Lymph nodes
- Thyroid adenoma
- Metastatic thyroid cancer
- Mediastinal adenopathy secondary to metastatic adenocarcinoma.
- Sarcoidosis and carcinoid tumors.

I-131 MIBG

- Analogue to Guanethidine
- Accumulates in presynaptic adrenergic nerves

TUMORS:

**pheochromocytoma, paraganglioma, neuroblastoma,
carcinoids and medullary**

131-MIBG

Compound	Adults	Children (15–50 kg)	Children (5–15 kg)	Children (<5 kg)
Capsules	mg/daily			
Potassium iodate	170	80	40	20
Potassium iodide (KI)	130	65	32	16
Lugol solution 1%	1 drop/kg per day with a maximum of 40 (20 drops twice daily)			
Capsules	mg/daily			
Potassium perchlorate	400	300	200	100

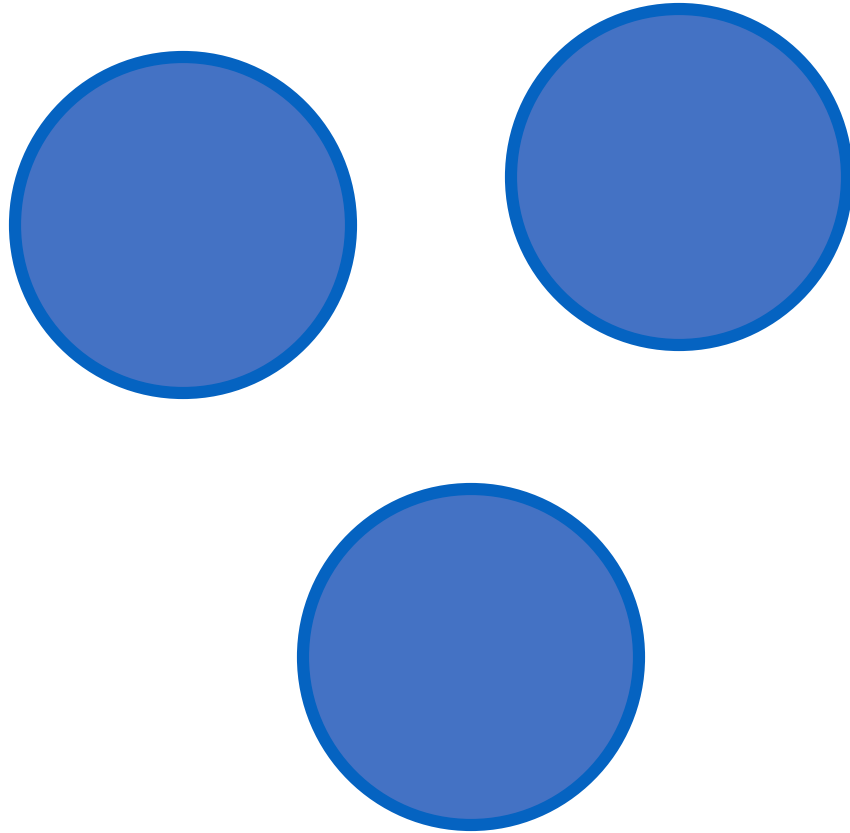
Drug group	Approved name	Recommended withdrawal	
Cardiovascular and sympathomimetic drugs			
Antiarrhythmics for ventricular arrhythmias	Amiodarone	Not practical to withdraw	
Combined α/β -blocker	Labetalol	72 hours	
Adrenergic neurone blockers	Bretylium	48 hours	
	Guanethidine	48 hours	
	Reserpine	48 hours	
α -Blocker	Phenoxybenzamine (intravenous doses only)	15 days	
Calcium channel blockers	Amlodipine	48 hours	
	Diltiazem	24 hours	
	Felodipine	48 hours	
	Isradipine	48 hours	
	Lacidipine	48 hours	
	Lercanidipine	48 hours	
	Nicardipine	48 hours	
	Nifedipine	24 hours	
	Nimodipine	24 hours	
	Nisoldipine	48 hours	
	Verapamil	48 hours	
	Inotropic sympathomimetics	Dobutamine	24 hours
		Dopamine	24 hours
Dopexamine		24 hours	
Vasoconstrictor sympathomimetics	Ephedrine	24 hours	
	Metaraminol	24 hours	
	Norepinephrine	24 hours	
	Phenylephrine	24 hours	
β_2 stimulants (sympathomimetics)	Salbutamol	24 hours	
	Terbutaline	24 hours	
	Eformoterol	24 hours	
	Bambuterol	24 hours	
	Fenoterol	24 hours	
	Salmeterol	24 hours	
	Orciprenaline	24 hours	
Other adrenoceptor stimulants	Pseudoephedrine	48 hours	
	Systemic and local nasal decongestants, compound cough and cold preparations	Phenylephrine	48 hours
		Ephedrine	24 hours
		Xylometazoline	24 hours
		Oxymetazoline	24 hours
Sympathomimetics for glaucoma	Brimonidine	48 hours	
	Dipivefrine	48 hours	
Neurological drugs			
Antipsychotics (neuroleptics)	Chlorpromazine	24 hours	
	Benperidol	48 hours	

Table 2 (continued)

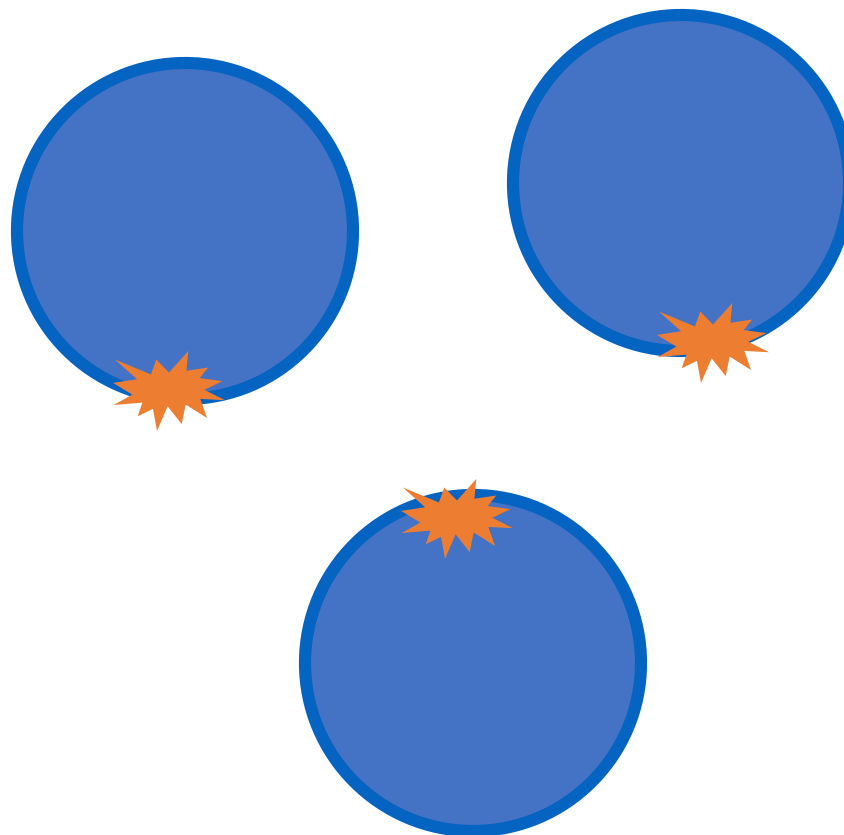
Drug group	Approved name	Recommended withdrawal time
	Perphenazine	24 hours
	Pimozide	72 hours
	Pipotiazine	1 month for depot
	Prochlorperazine	24 hours
	Promazine	24 hours
	Sulpiride	48 hours
	Thioridazine	24 hours
	Trifluoperazine	48 hours
	Zacloprathixol	48 hours, or 1 month for depot
	Amisulpride	72 hours
	Clozapine	7 days
	Olanzapine	7–10 days
	Quetiapine	48 hours
	Risperidone	5 days or 1 month for depot
	Sertindole	15 days
	Zotepine	5 days
Sedating antihistamines	Promethazine	24 hours
Opioid analgesics	Tramadol	24 hours
Tricyclic antidepressants	Amitriptyline	48 hours
	Amoxapine	48 hours
	Clomipramine	24 hours
	Dosulepin (dothiepin)	24 hours
	Doxepin	24 hours
	Imipramine	24 hours
	Lofepamine	48 hours
	Nortriptyline	24 hours
	Trimipramine	48 hours
Tricyclic-related antidepressants	Maprotiline	48 hours
	Mianserin	48 hours
	Trazolone	48 hours
	Venlafaxine	48 hours
	Mirtazepine	8 days
	Reboxetine	3 days
CNS stimulants	Amphetamines, e.g. dexamfetamine	48 hours
	Atomoxetine	5 days
	Methylphenidate	48 hours
	Modafinil	72 hours
	Cocaine	24 hours
	Caffeine	24 hours

Therapeutic Aim

γ -emitters



β -emitters



•

¹³¹I therapy

- Indications
 - Thyroid carcinoma
 - Thyrotoxicosis
 - Non-toxic goiter

Results (in hyperthyroidism)

- Cure > 90% with a single dose
- Most patients eventually become hypothyroid (need for replacement hormone therapy)
- Lower risk of hypothyroidism after treatment of solitary hyperfunctioning nodules
- In hyperthyroidism high dose is better (possible malignancy in remnant untreated tissue)

Minimal Complications

- No statistically significant increase in thyroid and other malignancies
- No reduction in fertility
- No congenital defect in children of treated individuals
- Thyroid storm after therapy as a risk
- Local neck pain, tenderness and swelling for few days

Pre-conception irradiation

- Pre-conception irradiation of either parent's gonads has **not** been shown to result in increased risk of cancer or malformations in children
- This statement is from comprehensive studies of atomic bomb survivors as well as studies of patients who had been treated with radiotherapy when they were children

Important Contra-indications For Treatment of Hyperthyroidism with ^{131}I

- Pregnancy should be ruled out (avoiding of pregnancy 6 to 12 months after treatment)
- Breast feeding.

Contraindication of ^{131}I therapy

- A pregnancy test must be performed before the time (usually within 72 hours).
- Pregnancy should be delayed for at least 6 months after radioiodine therapy, a delay based on the need to normalize thyroid levels for a successful pregnancy and healthy infant development, and to ensure that additional radiation treatment is not imminent.

Contraindication of ^{131}I therapy

- Lactating breast concentrates a substantial amount of iodide.
- Breastfeeding must be stopped at least 6 weeks before administration of ^{131}I therapy, and a delay of 3 months will more reliably ensure that lactation-associated increase in breast **sodium iodide symporter** activity has returned to normal.

Contraindication of ^{131}I therapy

- Breast feeding should not be resumed after administration of ^{131}I .
- Breastfeeding can be safely undertaken after future Pregnancies.

Preparation for I131 (Scan or cancer treatment)

➤ The patient discontinues the long-acting thyroid hormone

T4 for 4 to 6 weeks, until the TSH level is greater than 30 U/mL.

➤ To minimize hypothyroid symptoms, some patients are prescribed a shorter half-life T3 thyroid hormone analog, triiodothyronine.

➤ This drug must be discontinued 2 weeks before radioiodine administration to ensure an adequate rise in the serum TSH.

Recombinant Thyroid-Stimulating Hormone (Thyrogen) Alternative to Thyroid Hormone Withdrawal.

- Administered on 2 consecutive days as an intramuscular injection of 0.9 mg.
- A serum TSH level is usually obtained.
- On the third day, radioiodine is administered.
- Imaging is performed on day 5 for I-131 and day 4 for I-123.

***Recombinant Thyroid-Stimulating Hormone (Thyrogen)
Alternative to Thyroid Hormone Withdrawal.***

- Hypothyroidism causes a decrease in the glomerular filtration rate (GFR) and radioiodine clearance.
- Recombinant TSH does not affect GFR
- To expose thyroid cancer cells to similar extracellular radioiodine and maximize opportunity for uptake, a larger administered dose is required using recombinant TSH?.

Instructions for the Patient (Received 131-I 5-29 mci)

1. Avoid close contact with children and pregnant women for at least the first 2 days (occasional hug is not harmful)
2. Maintain a careful distance from others for at least the first 2 days (two arm lengths).
3. Sleep alone in a room for at least the first night.

Instruction for the Patient (cont,)

4. Do not travel by airplane or mass transportation for at least the first day.
5. Do not travel on a prolonged automobile trip (>2 hours) with others for at least the first 2 days.
6. Flush the toilet 3 times after use.
7. Avoid kissing contact for at least 1 week

Instruction for the Patient (cont,)

8. Clothing worn during the first 3 days after the therapy dose that was directly in contact with skin should be laundered separately.
9. Drink plenty of extra fluids for 2 days

Radiation detectors at ports of entry

- It is possible that patients treated with ^{131}I could trigger alarms at such detection sites for 95 days or longer after treatment.
- If, within 4 months of receiving ^{131}I therapy, travel is planned a form should be provided to the patient

Instructions for the Patient (Received 131-I 5-29 mci)

For 1 week after treatment:

- Men and women: flush the toilet twice with the lid down after each use.
- Wash hands frequently. Shower daily, cleaning shower or tub afterward.
- Do not engage in kissing or sexual relations.
- Do not share food or drink with others.
- Place eating utensils in the dishwasher or wash them separately from others.
- Dispose of your toothbrush after using for 1 week

Patient Instructions After I-131 Therapy for Thyroid Cancer

- **For 3 days after treatment:**
- Avoid prolonged sitting near others, including during travel.
- Sleep in a separate bed.
- Avoid close contact with children.
- Drink at least 2 quarts of fluid daily.
- Use sour candy to keep saliva flowing.

Patient Instructions After I-131 Therapy for Thyroid Cancer

For 1 week after treatment:

- Men and women: Sit while urinating, and flush the toilet twice with the lid down after each use.
- If possible, use a separate bathroom. If not possible, clean the toilet seat after use
- Wash hands frequently.
- Shower or bathe daily, cleaning the tub or sink afterward.
- Cover mouth when coughing or sneezing.
- Do not engage in kissing or sexual relations.
- Use separate towels and bed linens. Launder these items separately.
- Do not share food or drink with others.
- Place eating utensils in the dishwasher or wash them separately from others.
- Dispose of toothbrush after using for 1 week.

Thyroid cancer 131-I Instruction ATA 2011

	<i>mCi (MBq) administered</i>			
	50 (1850)	100 (3700)	150 (5550)	200 (7400)
Nighttime restrictions				
Sleep in a separate (6-foot separation) bed from adults for days shown.	1	1	2	4
Sleep in a separate bed from pregnant partners, infant, or child for days shown.	6	13	18	21
Daytime restrictions				
You may return to work after days shown.	1	1	1	1
Maximize your distance (6 feet) from children and pregnant women for days shown.	1	1	1	1
Avoid extended time in public places for days shown.	1	1	1	1

Hyperthyroidism 131-I Instruction ATA 2011

	<i>mCi (MBq) administered</i>			
	<i>10 (370)</i>	<i>15 (555)</i>	<i>20 (740)</i>	<i>30 (1110)</i>
Nighttime restrictions				
Sleep in a separate (6-foot separation) bed from adults for days shown.	3	6	8	11
Sleep in a separate bed from pregnant partners, infant, or child for days shown.	15	18	20	23
Daytime restrictions				
You may return to work after days shown.	1	1	2	5
Maximize your distance (6 feet) from children and pregnant women for days shown.	1	1	2	5
Avoid extended time in public places for days shown.	1	1	1	3

Inpatient or Outpatient

- At many centers, patients are treated primarily on an outpatient basis. For very-highdose therapy (>200 mCi) or for reason of radiation safety for family members, patients may be treated as inpatients.

Low risk
Papillary thyroid cancer with all of the following present:
<ul style="list-style-type: none"> ■ No local or distant metastases
<ul style="list-style-type: none"> ■ All macroscopic tumor has been resected
<ul style="list-style-type: none"> ■ No invasion of locoregional tissues
<ul style="list-style-type: none"> ■ Tumor does not have aggressive histology (aggressive histologies include tall cell, insular, columnar cell carcinoma, Hürthle cell carcinoma, follicular thyroid cancer, hobnail variant)
<ul style="list-style-type: none"> ■ No vascular invasion
<ul style="list-style-type: none"> ■ No ¹³¹I uptake outside the thyroid bed on the post-treatment scan, if done
<ul style="list-style-type: none"> ■ Clinical N0 or ≤5 pathologic N1 micrometastases (<0.2 cm in largest dimension)*
Intrathyroidal, encapsulated follicular variant of papillary thyroid cancer*
Intrathyroidal, well-differentiated follicular thyroid cancer with capsular invasion and no or minimal (<4 foci) vascular invasion*
Intrathyroidal, papillary microcarcinoma, unifocal or multifocal, including <i>BRAF</i> V600E mutated (if known)*

Intermediate risk

Any of the following present:

Microscopic invasion into the perithyroidal soft tissues

Cervical lymph node metastases or ^{131}I avid metastatic foci in the neck on the post-treatment scan done after thyroid remnant ablation

Tumor with aggressive histology or vascular invasion (aggressive histologies include tall cell, insular, columnar cell carcinoma, Hürthle cell carcinoma, follicular thyroid cancer, hobnail variant)

Clinical N1 or >5 pathologic N1 with all involved lymph nodes <3 cm in largest dimension*

Multifocal papillary thyroid microcarcinoma with extrathyroidal extension and *BRAF* V600E mutated (if known)*

High risk

Any of the following present:

Macroscopic tumor invasion

Incomplete tumor resection with gross residual disease

Distant metastases

Postoperative serum thyroglobulin suggestive of distant metastases

Pathologic N1 with any metastatic lymph node ≥ 3 cm in largest dimension*

Follicular thyroid cancer with extensive vascular invasion (>4 foci of vascular invasion)*

Renal failure and ¹³¹I Thyroid Cancer

In patients with renal failure or on hemodialysis, there are two dosing approaches to radioiodine therapy of DTC:

- Substantially lower dose of radioiodine followed by the patient's usual dialysis schedule.
- Standard radioiodine dose followed by more frequent dialysis.

Renal failure and ^{131}I Hyperthyroidism

- In hyperthyroidism a larger fraction OF ^{131}I is taken up by the thyroid tissue, requiring less clearance by the kidney immediately after ingestion.
- Hemodialysis should be performed after the time of maximum uptake in thyroid (10 hours).



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