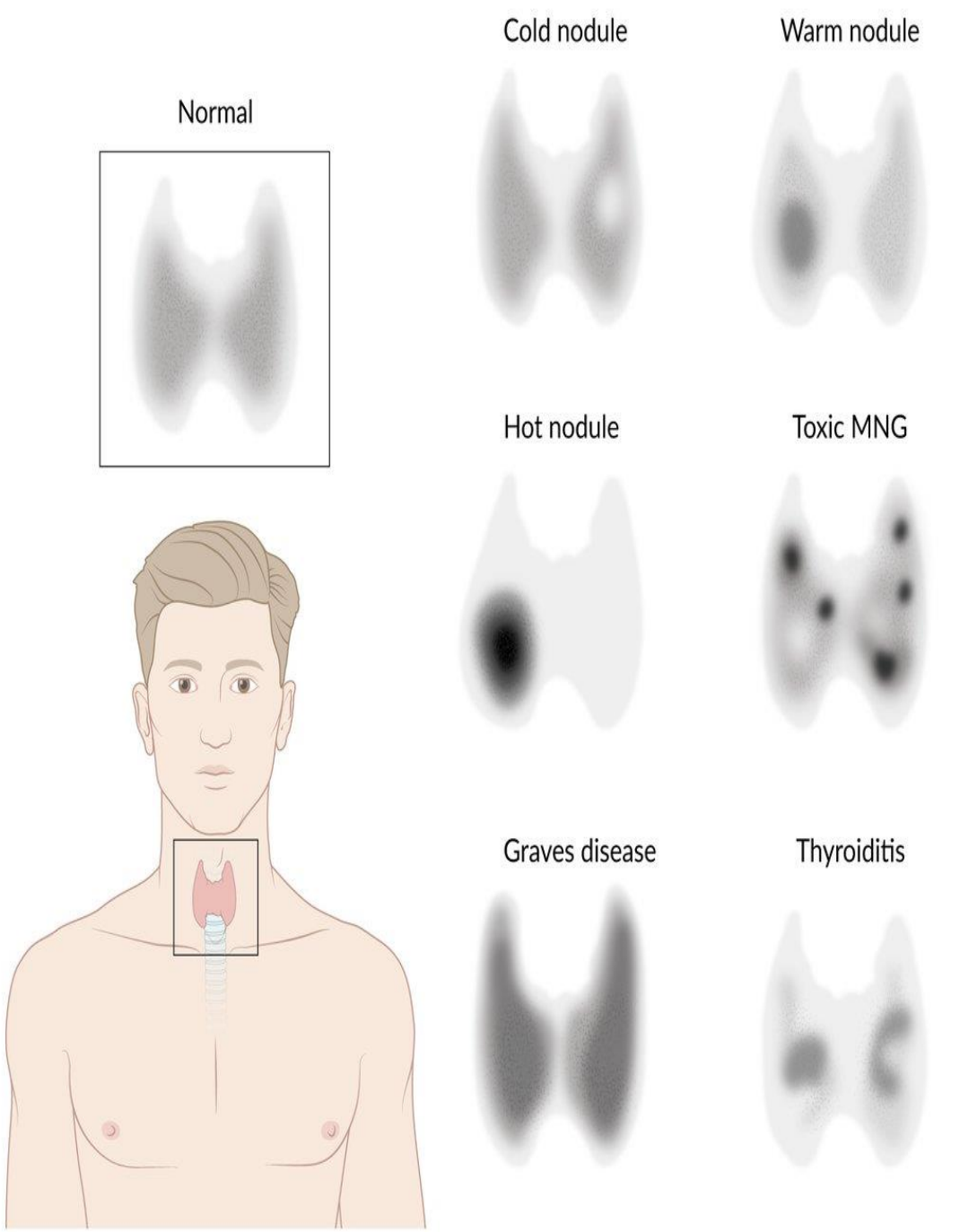


Thyroid Scintigraphy

Dr.M.Mohseni

Nuclear medicine physician

What is a thyroid scan?

A thyroid scan (thyroid scintigraphy) is a diagnostic nuclear medicine test that provides information about the structure and function of the thyroid (the size, shape, position, and function of the thyroid gland).

Indications:

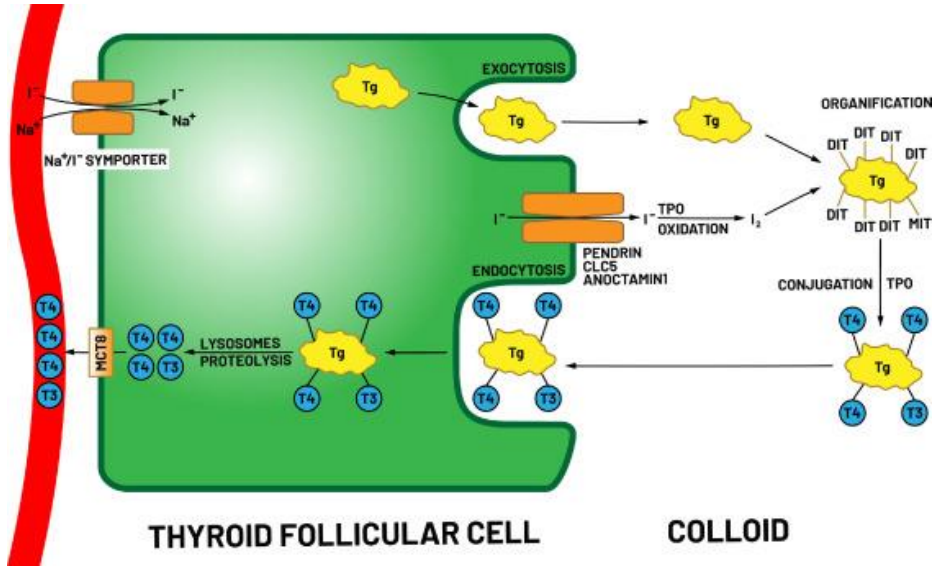
- Evaluation of the general structure of the thyroid gland (e.g. nodular or diffuse enlargement) relative to its function
- Differential diagnosis of hyperthyroidism, i.e. distinguishing Graves' disease from toxic nodular goiter or factitious hyperthyroidism
- Determine the degree of function in a nodule that is palpable or found incidentally at a nonnuclear imaging procedure.
- Location of ectopic thyroid tissue (e.g., lingual, incomplete thyroid descent).
- Evaluation of congenital hypothyroidism (total agenesis or hemiagenesis, dyshormonogenesis, incomplete thyroid descent).
- Evaluation of a neck or substernal mass. Scintigraphy may be helpful to confirm that the mass is functioning thyroid tissue.
- Differentiation of thyroiditis (i.e. viral, autoimmune) determining the therapeutic dosage of I-131 and predicting the outcome and potential side effects of therapy.

Indications:

- Evaluation of thyroid nodules with indeterminate FNA-biopsy result
- Both thyroid scintigraphy and RAIU testing are used to differentiate between productive thyrotoxicosis (i.e., hyperthyroidism) vs. destructive thyrotoxicosis (i.e., acute and subacute thyroiditis) and factitious thyrotoxicosis.

Table 1 Indications for scintigraphic evaluation of thyroid nodules in different clinical guidelines

ATA 2015	German Endocrine Surgeons 2011	AACE/AME/ETA 2010 and 2016
-Nodules > 10–15 mm -TSH subnormal	-Thyroid nodules > 10 mm - Any TSH	-TSH < lower reference limit - Iodine deficiency: TSH < 1.0–1.5 mUI/L



Introduction

- The iodine uptake into the follicular cells is executed by the sodium-iodide symporter (NIS), a transmembrane protein located on the basolateral membrane of the thyroid follicular cells which functions as an energy (Na+/K + -ATPase)-dependent co-transport mechanism [1]. Under physiological conditions, the expression and activity of NIS are regulated by thyrotropin (thyroid-stimulating hormone, TSH) and modulated by cytokines such as TNF or TGF-1. Iodide (I–) is the ionized form of iodine and it is translocated via an ionic channel across the apical membrane into the colloid, with pendrin (an anion exchange protein) playing a major role in this process [2]. Finally, the iodide oxidation into iodine and iodine organification into tyrosyl residues on the Tg molecule takes place at the outer (luminal) surface of the apical membrane of the epithelium.

99mTcO4 – has the advantages:

- daily ava daily availability in every nuclear medicine department
- lower cost and shorter physical half-life (6 h vs. 13 h)
- pure gamma emitter with a short half-life, relatively large amounts of activity can be given without imparting a large radiation dose to the thyroid
- high-quality images are obtained due to the high flux and favorable energy of the gamma photons.

reflects only thyroid trapping ability as it does not undergo further metabolism

99mTc-natrium (sodium) pertechnetate

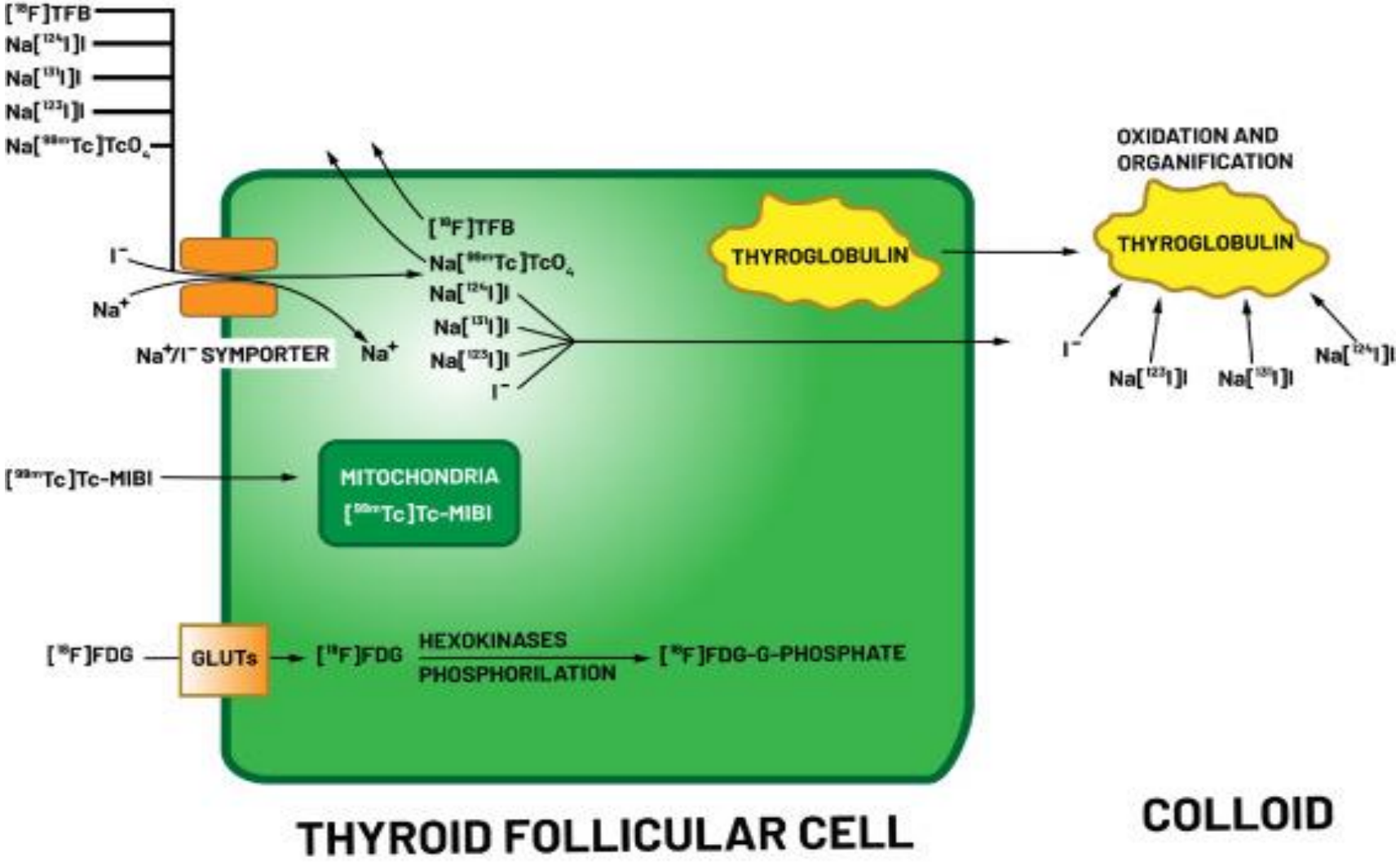
- 99mTc-natrium (sodium) pertechnetate (99mTcO4−) is a pharmacologic mimic of iodine which is concentrated within the thyroid cells by NIS activity; however, it is not organified and therefore washout from thyroid cells occurs after 30 min of radiotracer injection.

Radiopharmaceuticals

- **NIS-targeting radiopharmaceuticals are well suited for thyroid imaging and radioiodine uptake (RAIU) study.**
-
- **Additionally, imaging with specific tracers such as 99mTc-sestamibi (99mTc-MIBI) and 18F-fluorodeoxyglucose (18FDG) may be useful in selected cases to help in discriminating benign from malignant thyroid nodules.**

Table 4 Thyroid radiopharmaceuticals

	^{131}I-	^{123}I-	$^{99m}TcO_4^-$	^{99m}Tc-sestamibi	^{18}FDG
Administration	p.o.	p.o.	i.v.	i.v.	i.v.
Activity [MBq] (adults)	0.15–0.37	7.4–14.8	74–111	185–370	200–370
Energy [Kev] (γ peak)	364	159	140	140	511 KeV
Physical half-live	8.06 days	13.2 h	6.04 h	6.04 h	110 min
Effective dose (mSv/MBq)	11	0.20	0.013	0.009	0.02 (PET) 0.04 (PET/CT)



Different thyroid radiopharmaceuticals and their uptake mechanisms

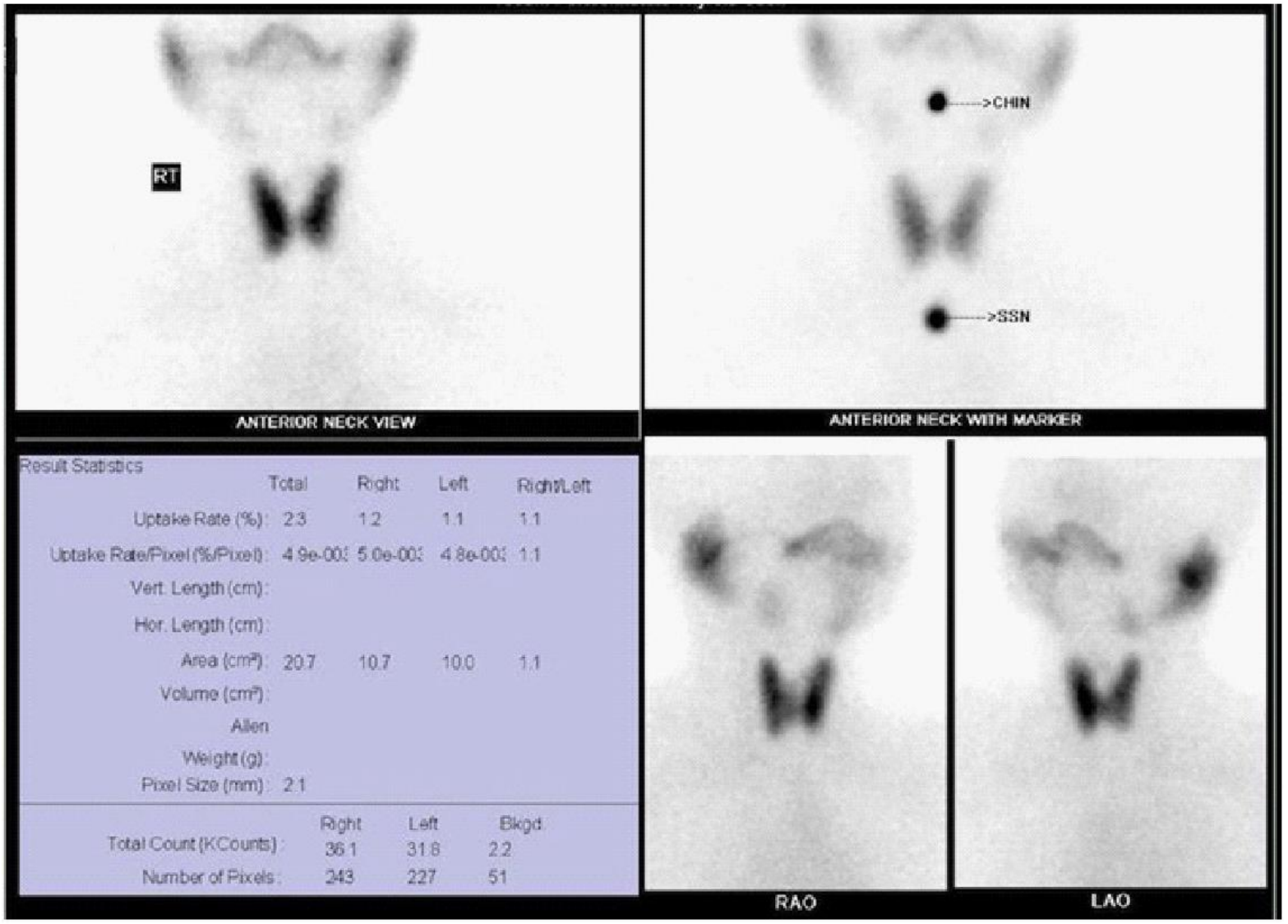
Patient preparation

- No fasting
- Immediately prior to imaging, the patient is asked to swallow water to clear activity from mouth and esophagus
- The patient should be supine with the neck extended and supported by a pillow placed under the shoulders. In patients who are unable to lie supine, the sitting position may be employed

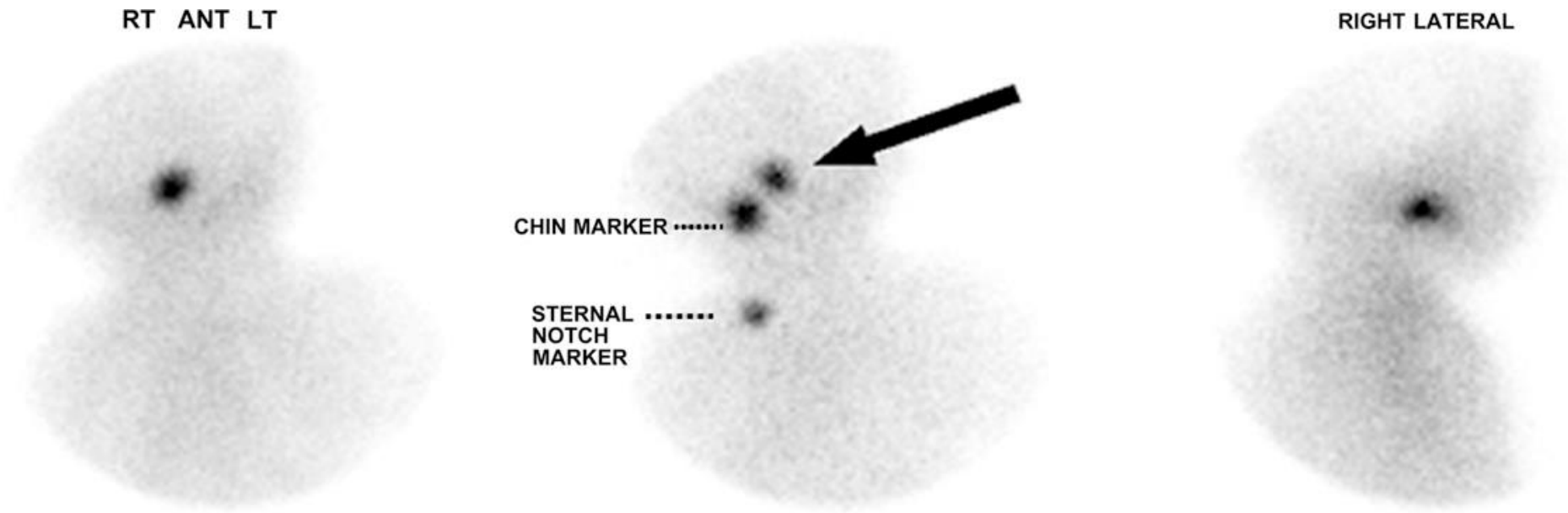
- **Imaging is generally acquired as follows:**

- – At2–6h(early imaging) and 24h(delayed imaging) after oral 123I
- – At 15–20 min after intravenous 99mTcO4
- – At 10–30 min (early imaging) and 60–120 min (delayed imaging) after intravenous 99mTc-sestamibi
- – At 50–70 min after intravenous 18FDG

- An anterior image of the neck is acquired for 100200×103 counts or 5–10 mine.
- Both anterior oblique images should be obtained for the same amount of time as the anterior image. SPECT(-CT) acquisitions can be performed on indication,especially if substernal or ectopic thyroid is an issue.
- The distance between the pinhole aperture and the neck should be adjusted so that the image of the thyroid occupies the central two-thirds of the field of view



anterior oblique images



Tc 99m pertechnetate scan in a 12-month-old child with hypothyroidism with an ectopic lingual thyroid (arrow).

- **Radioactive or radiopaque markers can be used to identify anatomical landmarks (e.g. sternal notch, thyroid cartilage) and the location of palpable nodules. Localizing markers for nodules should be centered in the field of view to avoid parallax. Duplicate views should be obtained without the markers**

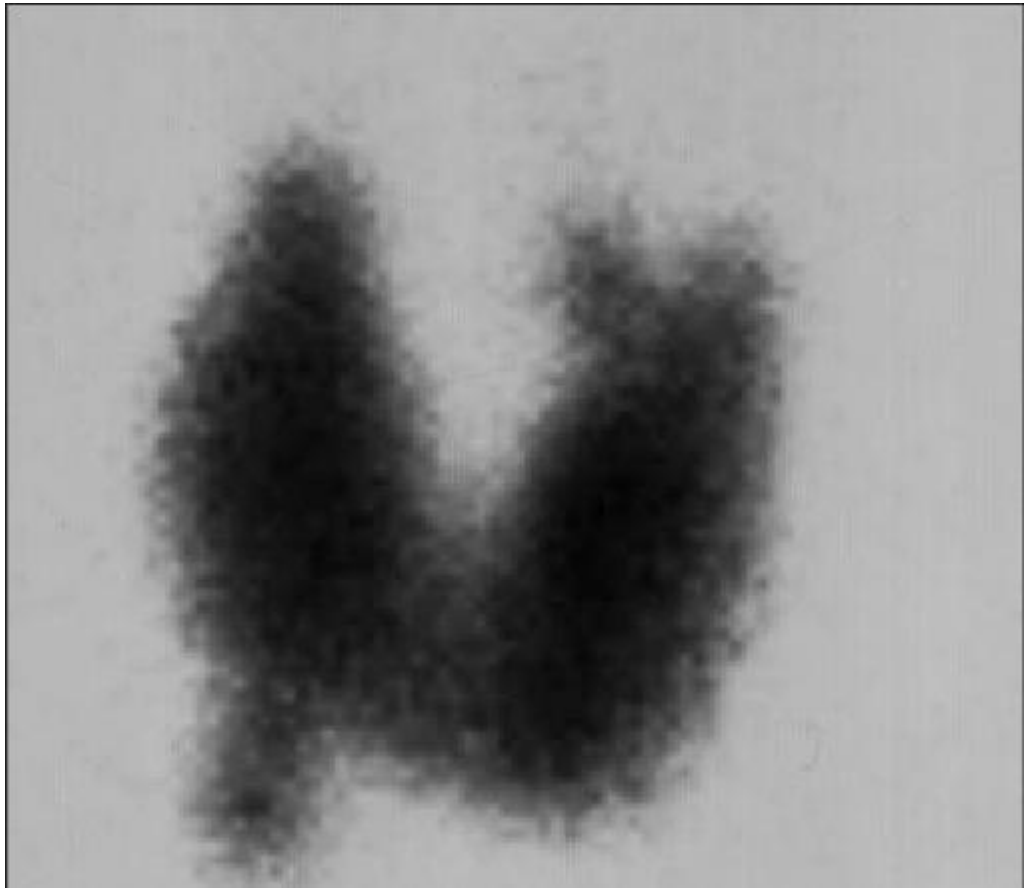
Interpretation criteria and reporting

- 123I- or 99mTcO4− uptake as compared to that demonstrated in the **salivary glands** (less than, equal to, or more than salivary activity) may serve as a rough approximation of the overall thyroid function.
- However, an accurate assessment of iodine uptake and kinetics can only be obtained by performing a RAIU test

Interpretation criteria and reporting

- On planar scintigrams, the normal gland is butterfly-shaped and does not extend substernally. The isthmus may, or may not, be visualized and a pyramidal lobe can be recognized in about 10% of patients.
- Tracer activity is normally evenly distributed throughout the thyroid gland and both salivary glands and gastric mucosa are normally visualized because they also express the NIS glycoprotein
- A hypofunctioning “cold” thyroid nodule has reduced tracer uptake, an isofunctioning “warm” nodule has tracer uptake roughly equivalent to non-nodular thyroid tissue, and a hyperfunctioning “hot” nodule has increased radiotracer uptake. The term autonomously functioning thyroid nodule is frequently used as synonymous for “hot” nodules

It is seen as a third thyroid lobe and is present in 10-30% of the population.



Preoperative imaging of pyramidal lobe especially in patients requiring total thyroidectomy would decrease relapses

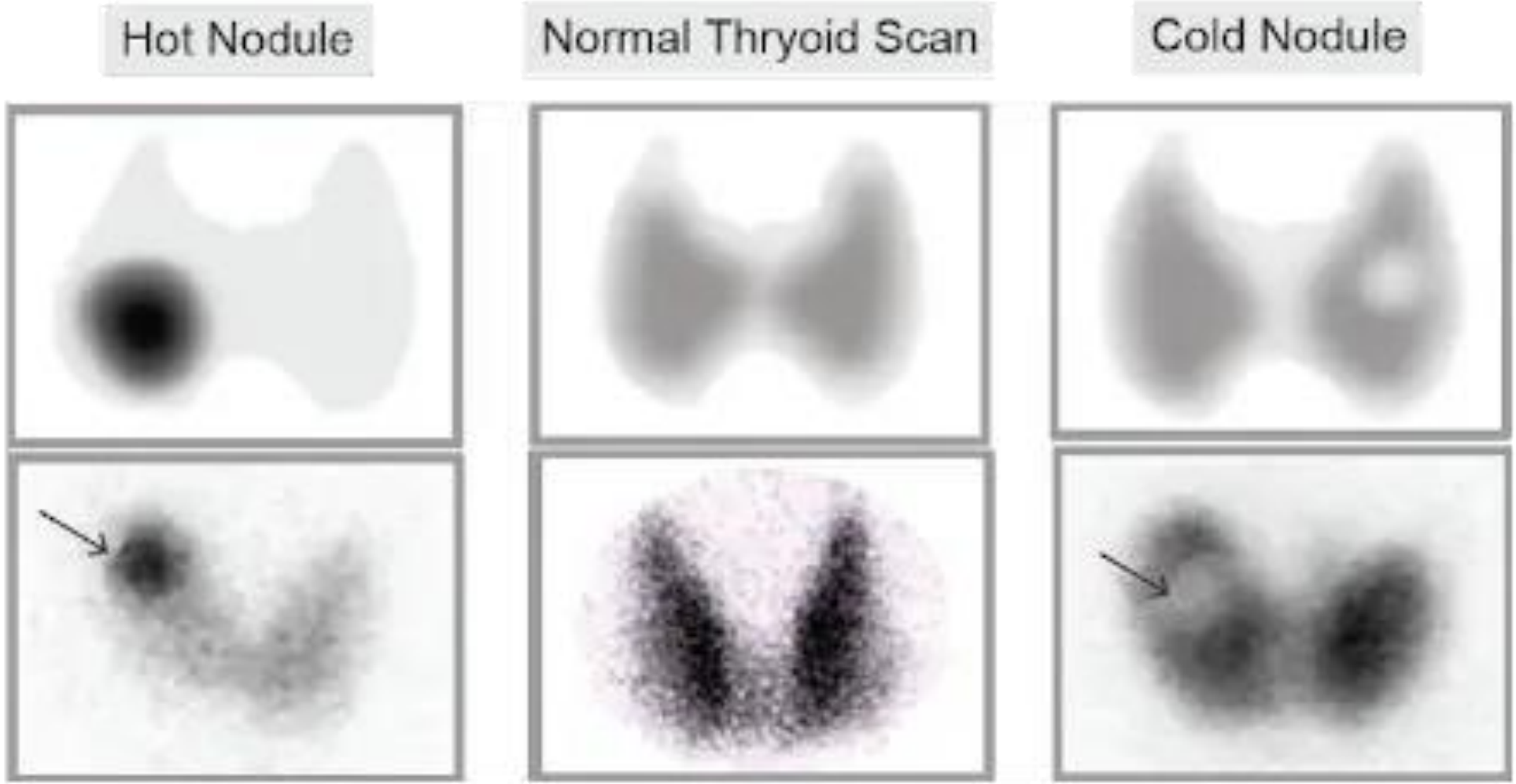
Visualisation of double pyramidal lobes on pinhole thyroid imaging with Tc-99m pertechnetate. b: Pyramidal lobes demonstrated on thyroid scan with low dose I-131.

Interpretation criteria and reporting

- Diffuse thyroid over activity with a homogeneous distribution of the tracer, reduced uptake in major salivary glands, and low background, consistent with Graves' disease.
- Autonomous hyperfunctioning nodules are easily identified and rarely malignant. However, it is necessary to be certain that there is suppressed thyroid tissue outside of the nodule, and that the absence of such uptake does not represent agenesis of a thyroid lobe. Palpation and ultrasound might be useful if this is a question

- Unifocal or multifocal overactive areas with reduced or suppressed uptake in the remaining thyroid tissue, consistent with autonomously functioning thyroid nodule(s)
- Multiple mixed areas of focal increased and suppressed uptake, consistent with toxic multinodular goiter.

- Localized areas of decreased function, when specifically correlated with a palpable nodule, may represent a hypofunctioning or “cold” nodule. Because of the difficulty in correlating findings on palpation with those on the scintigraphic image, efforts in localization using a **“hot” marker placed on the nodule** are important.
- It is also important to note that most hypofunctioning nodules do not represent malignancy but rather benign processes such as colloid nodules, follicular adenomas, cysts and, rarely, areas of fibrosis or localized thyroiditis


Hot Nodule
Normal Thryoid Scan
Cold Nodule

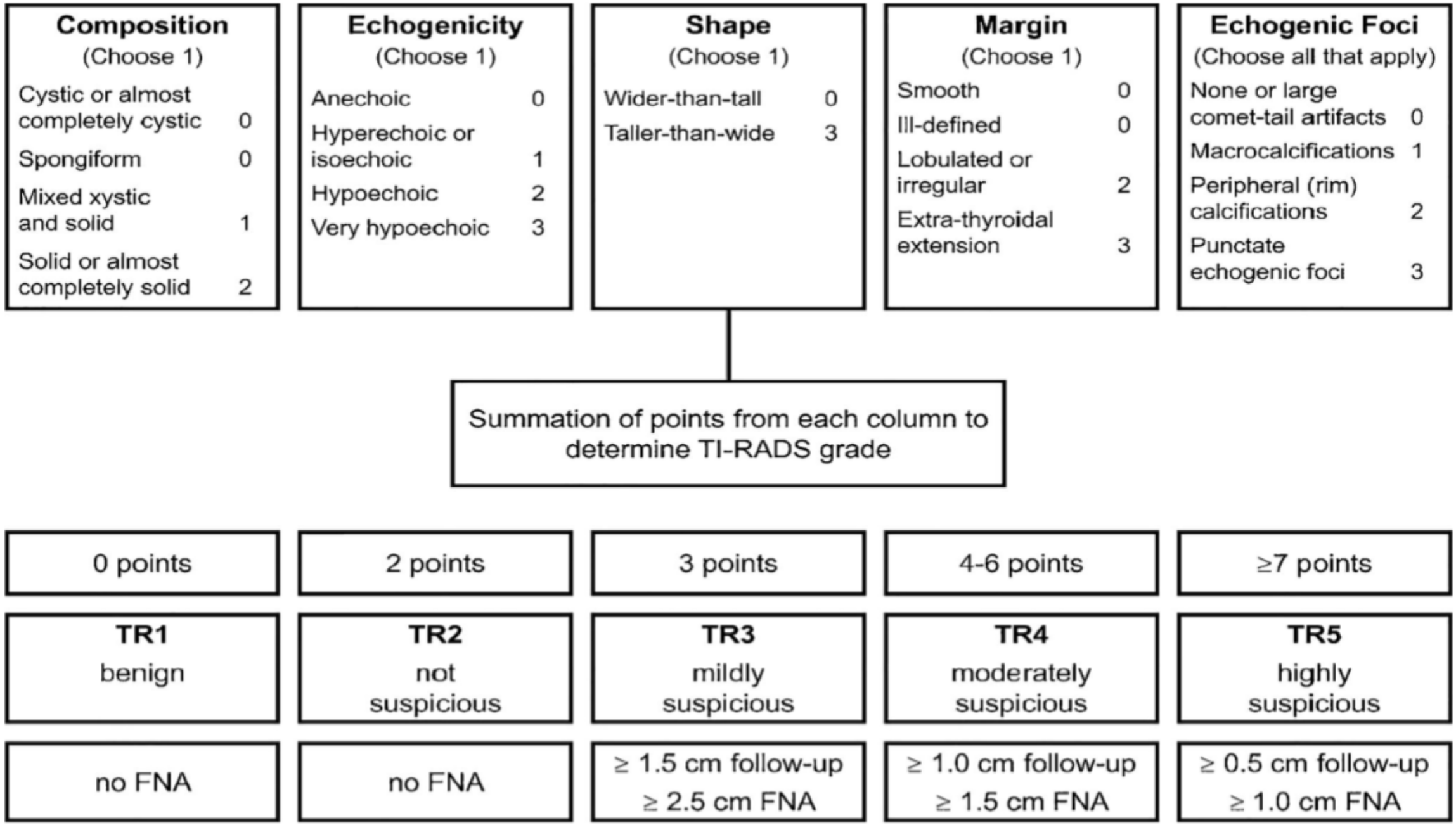


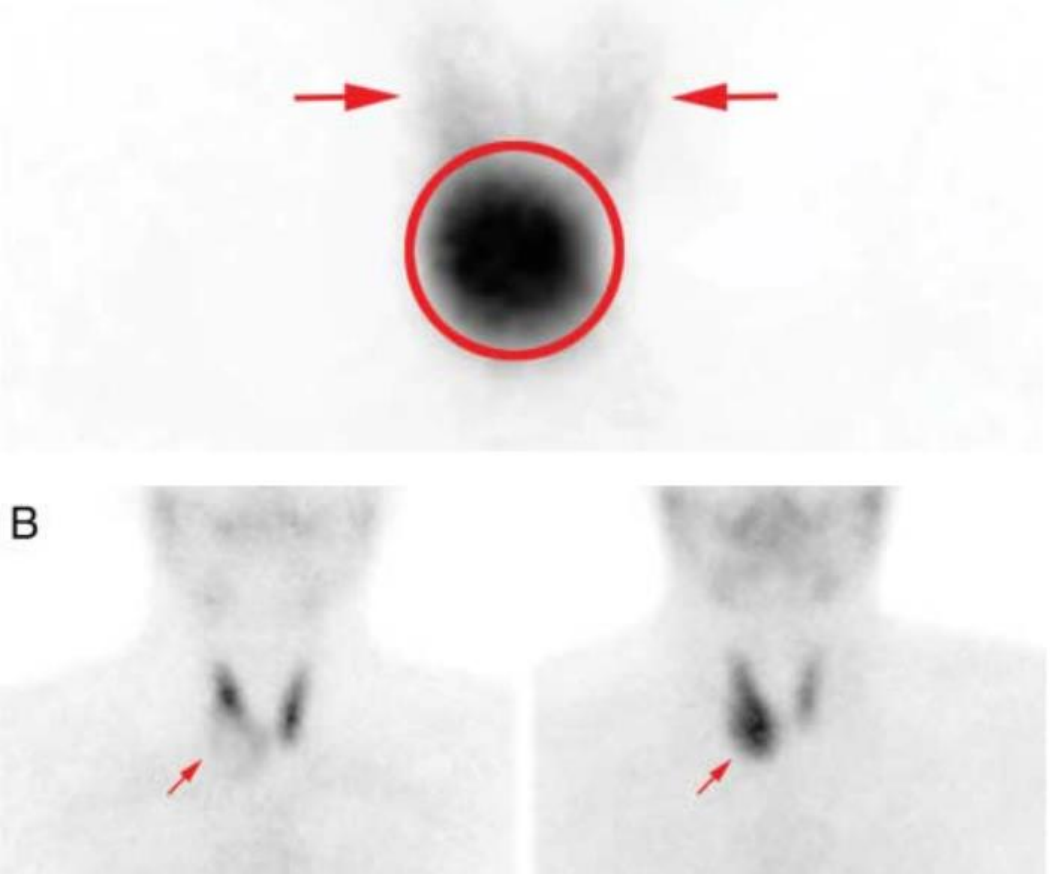
Fig. 1 American College of Radiology (ACR) TI-RADS classification of thyroid nodules and management recommendations

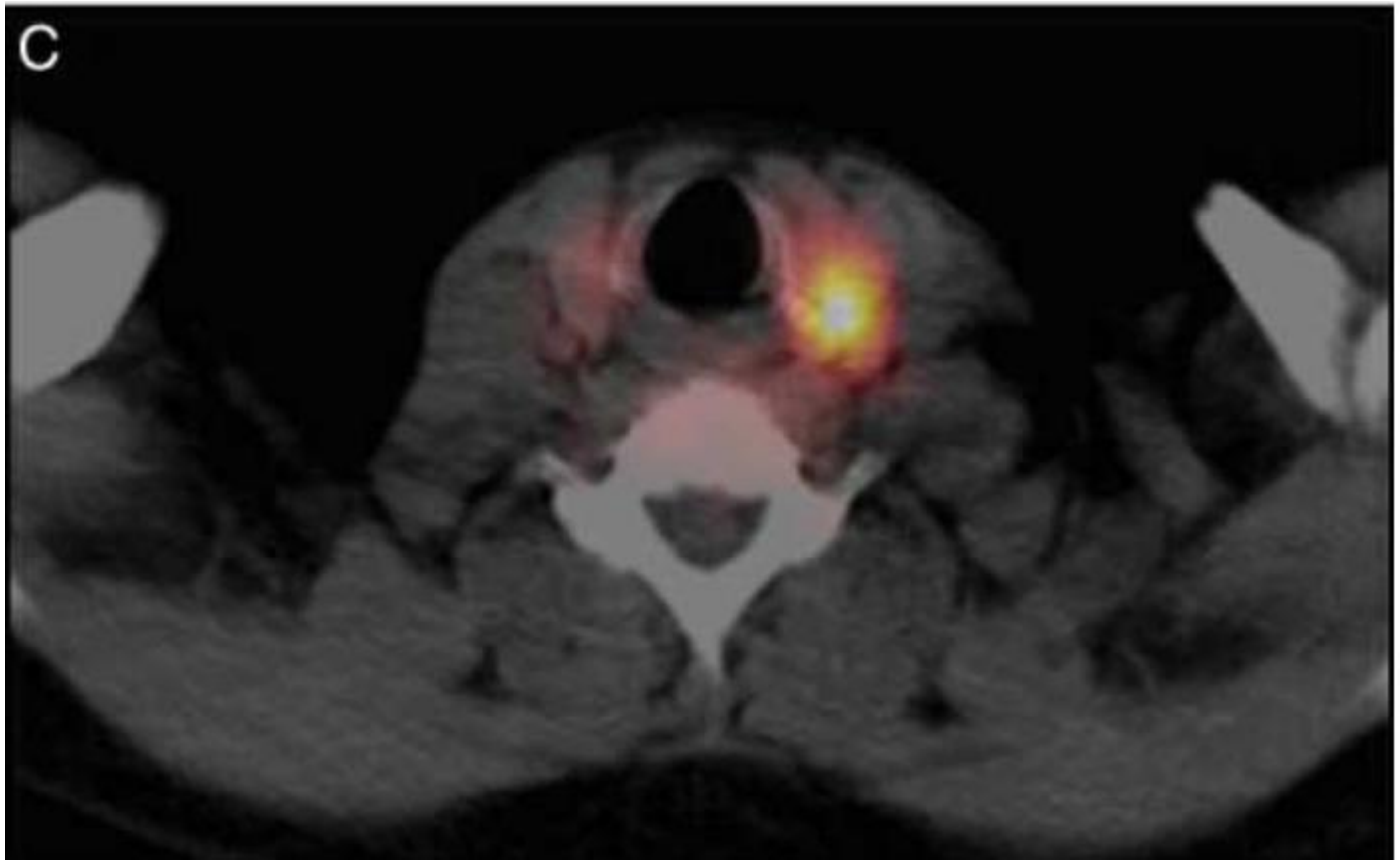
Sonography criteria VS Scintigraphy

- However, **none of the TI-RADS criteria addresses the functional status** of thyroid nodules, despite the fact that a scintigraphically hyperfunctioning (i.e., “hot”) thyroid nodule has a 96–99 % negative predictive value for malignancy.
- Thyroid scintigraphy is the only examination able to demonstrate the presence of autonomously functioning thyroid nodules (AFTN). Notably, while AFTN very rarely harbors malignancy, indeterminate cytology (e.g., Bethesda classes III and IV) is frequently reported in these cases. Accordingly, current clinical guidelines suggest refraining from FNA biopsy of AFTN to avoid unnecessary invasive procedures, including surgical resection for definitive histopathologic diagnosis.

autonomously functioning thyroid nodules (AFTN)

- More than 80 % of AFTN were classified as TIRADS ≥4 (i.e., moderately suspicious, requiring FNA for nodules ≥1.5 cm), only 16 % of AFTN were classified as TI-RADS ≤3, and <0.1 % of AFTN were classified as TIRADS 5.
- Therefore, integration of thyroid scintigraphy into TI-RADS model is essential to prevent unnecessary FNA biopsies for nodules that demonstrate autonomy.
- Non-invasive follicular thyroid neoplasm with papillary-like nuclear features (NIFTP) resulted in recalculation on the risk of malignancy in most recent 2017 Bethesda classification, since although NIFTP is no longer considered a thyroid carcinoma, surgery is nonetheless necessary for these nodules.





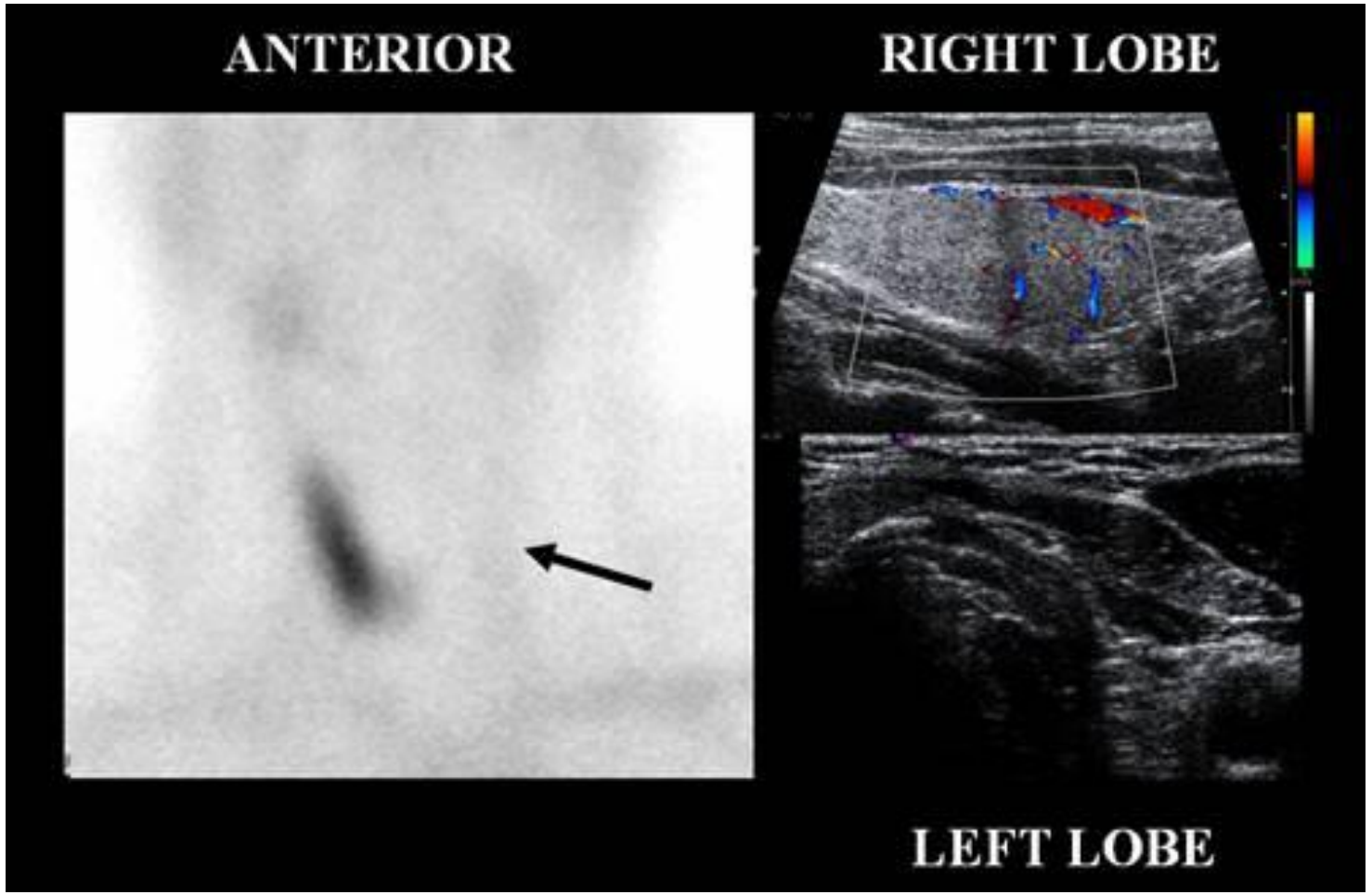
99m Tc-pertechnetate thyroid scan: autonomous thyroid nodule (red circle) with functional suppression of the surrounding thyroid parenchyma (red arrows). (B) 99m Tc-pertechnetate (left) and 99m Tc-SestaMIBI (right) double tracer thyroid scan. Left: hypofunctioning 'cold nodule' in the right thyroid lobe (arrow). Right: increased uptake of SestaMIBI in the same nodule indicating a suspicious pattern. (C) 18 FDG PET/CT (transaxial slice): hypermetabolic nodule in the left thyroid lobe indicating a suspicious pattern with a risk of malignancy of about 30%.

Evaluation and management of thyroid nodules with indeterminate cytology

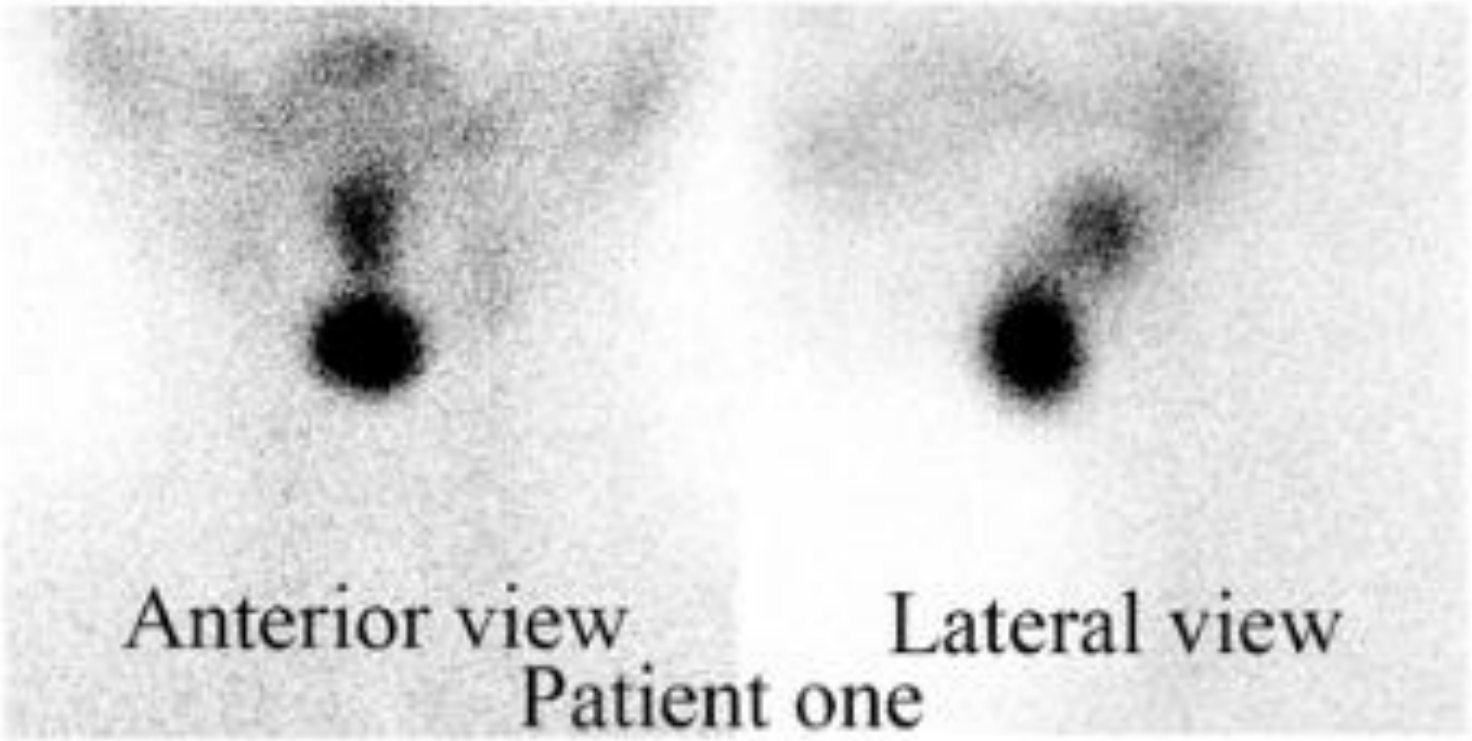
The risk of malignancy ranges from 10 to 30 % (class III or FLUS/AUS) to 25–40 % (class IV or follicular neoplasm). Repeat FNA biopsy, molecular testing, molecular imaging or diagnostic lobectomy can be performed; however, it is reasonable to first perform thyroid scintigraphy (if not previously obtained), particularly if the TSH is in the lower end of the normal range (e.g., less than 1.5mU/L) and only select patients with nonfunctioning nodules for molecular testing, molecular imaging, or diagnostic lobectomy

Evaluation of patients with congenital hypothyroidism

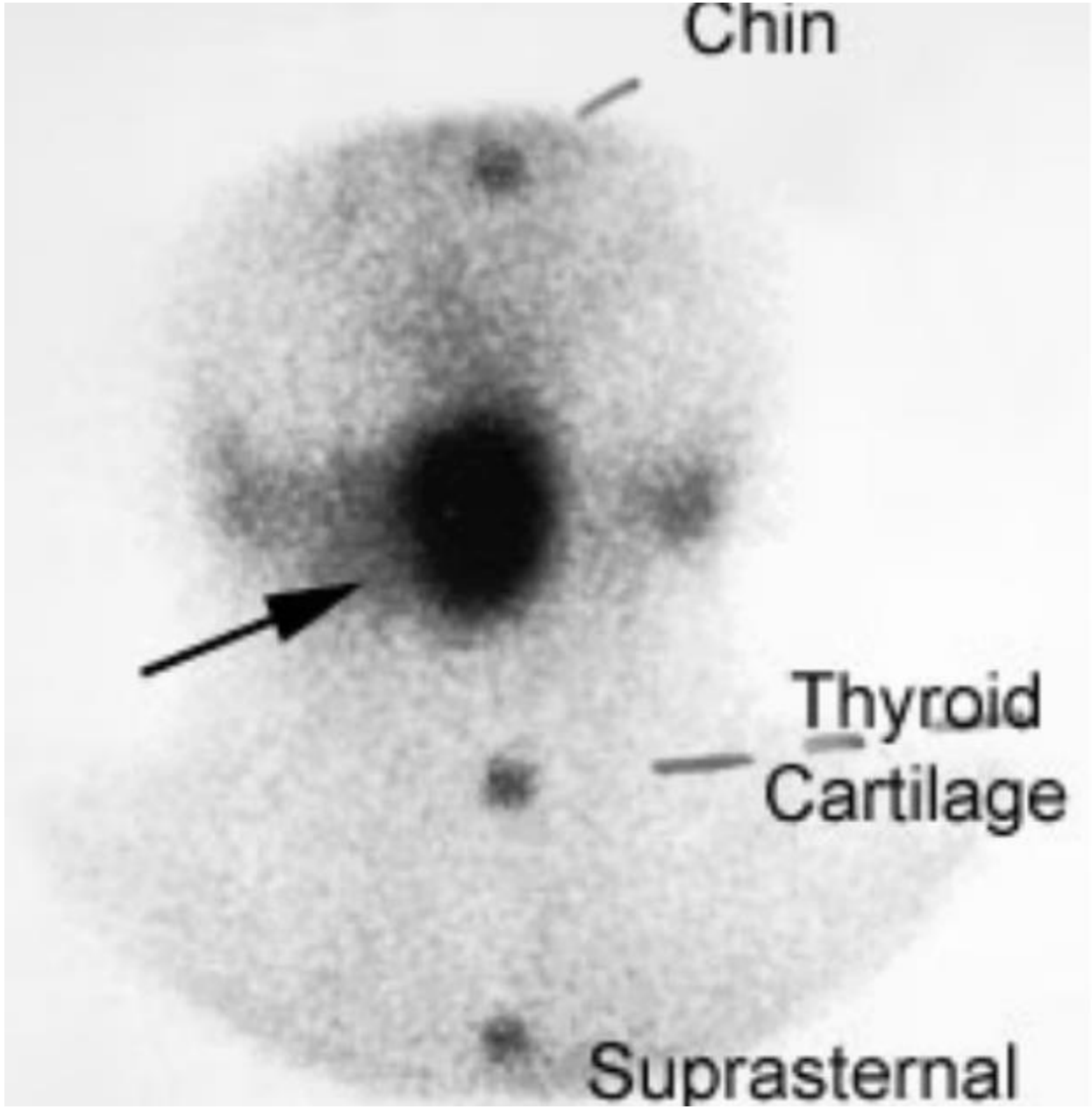
- the possible etiologies of CH include (1) thyroid dysgenesis (ectopia, hyperplasia, and agenesis); (2) defects in thyroid hormone synthesis (dyshormonogenesis); (3) hypothalamicpituitary CH; (4) transient CH due to iodine overload, maternal anti-thyroid antibodies, or anti-thyroid drug intake during pregnancy;
- Ultrasonography evaluates the presence of the thyroid gland and measures thyroid volume; however, it is **less sensitive** than scintigraphy for diagnosing thyroid ectopia and thyroid dyshormonogenesis



54 year old man being evaluated due to vague symptoms.
Left Lobe hemiagenesis

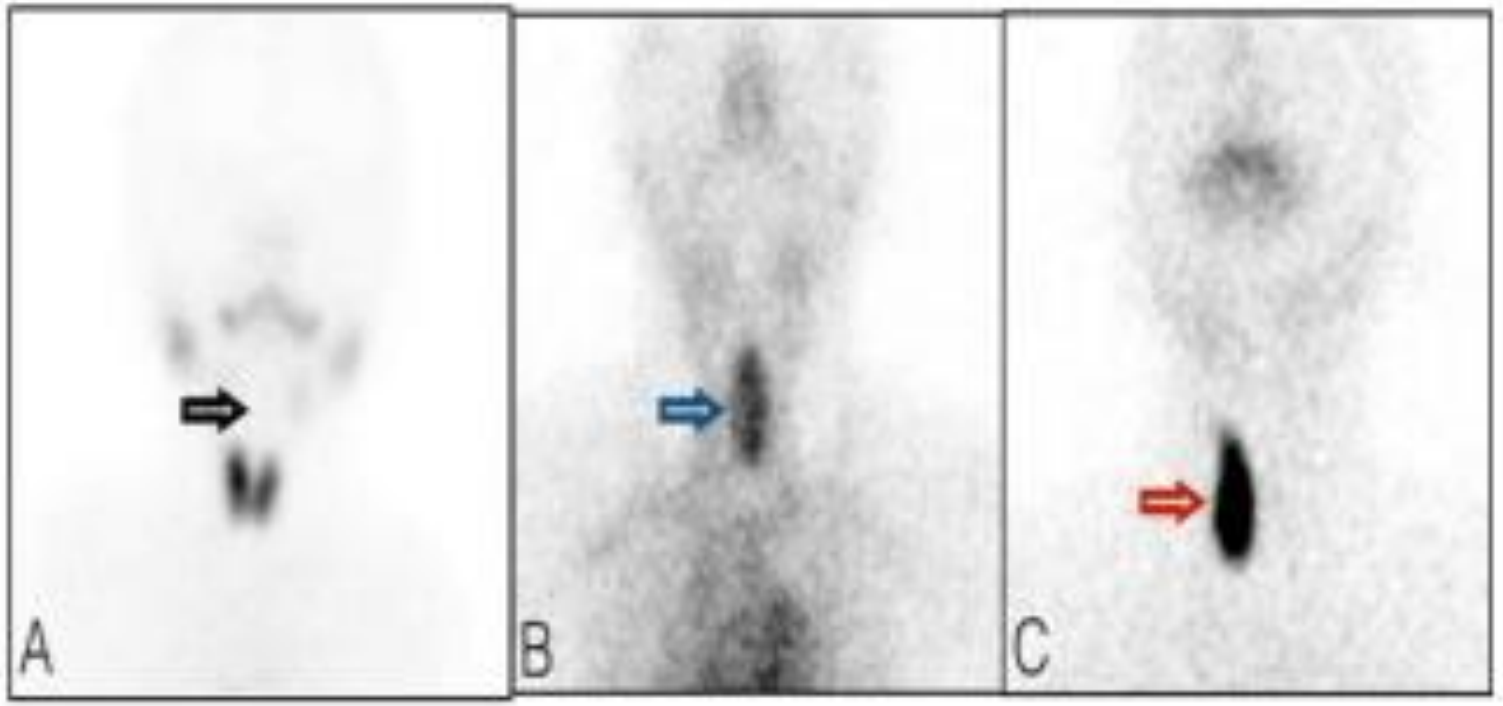


2 focal areas of abnormal ectopic radiotracer uptakes in the sublingual and subhyoid regions in thyroid scintigraphies. No evidence of radiotracer uptakes in the regions of orthotopic thyroid was found



lin**gual thyroid. No normal thyroid tissue can be seen in the thyroid bed.**

preoperative imaging may be performed to identify the anatomic extent of the cyst, identify ectopic thyroid tissue, and evaluate for potential malignancy within the cyst.



Functioning status of midline neck swelling on TS A) non-functioning (black arrow), B) functioning thyroglossal duct cyst (blue arrow), C) hemiagenesis with right lobe functioning (red arrow).

Semiquantitative evaluation of 99mTcO4– uptake (TcTU)

- to determine the percentage of the injected dose present in the gland,the TcTU is calculated as follow:
- measuring the syringe before and after injection and subtract counts in a background ROI from counts in a ROI drawn following the contour of the thyroid

$$\text{TcTU} = (\text{counts over thyroid–background counts})$$

$$\text{x } 100/\text{counts of injected activity}$$

TcTU results depend, as RAIU, on iodine intake and patient-related factors, such as the thyroid volume and, to a minor extent, the patient's age. Therefore, a local normal range should be established.

Sources of Error

- Local contamination (clothing, skin, hair, collimator, crystal)
- Esophageal activity (hiatal hernia)
- Suppression of iodine uptake by interfering substances

RAIU testing

- RAIU is increased in productive thyrotoxicosis (hyperthyroidism associated with toxic diffuse goiter and toxic uni- or multinodular goiter), while **destructive** and factitious thyrotoxicosis are typically associated with low or suppressed RAIU.
- Because of the large radiation dose to the thyroid (approximately one to three rads per uCi administered), the use of I-131 for thyroid scintigraphy should be discouraged (except when a subsequent treatment with I-131 is planned.
- A benefit of 123I is that it allows concurrent imaging of the gland.
- Administering activities as little as 3.7 MBq of 123I or 0.15 MBq of 131I

Indications

- Differentiating hyperthyroidism from other forms of thyrotoxicosis (e.g., destructive thyroiditis, factitious thyrotoxicosis, and iodine overload)
- Detecting iodine organification
- Useful for calculating the administered therapeutic activity of radioiodine to treat hyperthyroidism and euthyroid multinodular goiter.

Table 3 Factors that influence the thyroid uptake of iodine and iodine analogues radiopharmaceuticals and respective withdrawal time

Iodinated substances	Withdraw
Amiodarone	3 to 6 months
Intravenous contrast agents	1 to 2 months
Iodine-containing medicines and preparations	4 weeks
Iodine-containing antiseptics	4 weeks
Iodine solution (Lugol's or SSKI)	4 to 6 weeks
Oil-based-iodinated contrast agents	3 to 6 months
Kelp	4 weeks
Thyroid medications	Withdraw
Levothyroxine (LT4)	4 weeks
Liothyronine (LT3)	2 weeks
Anti-thyroid drugs (methimazole, carbimazole, PTU)	3 to 7 days
Perchlorate	1 week

Radiopharmaceutical	Advantages	Disadvantages
Tc-99m Pertechnetate	• Less expensive • More readily available • More rapid examination	• Trapped, but not organified • Activity in esophagus or vascular structures can be misleading • Poor image quality when uptake is low
I-123 iodide	• Better for visualization of retrosternal thyroid tissue • Yields better images when uptake is low	• Higher cost • May be less convenient for patient, as delayed imaging at 24 hr is often used • Less readily available • Imaging times are generally longer

- 123I− scintigraphy is the agent considered for children and on special request when an organification defect is suspected, while 99mTcO4− is preferred when the patient is lactating because of the shorter physical half-life of 99mTc.
- In very rare cases, the appearance of a thyroid nodule may be discordant on radioiodine and pertechnetate scans due to iodide organification defects in the nodule that results in a rapid washout of radioiodine (i.e., so-called “trapping only nodule”)

- Based on physiologic iodine metabolism within the thyroid gland, 123Inatrium (sodium) iodide (123I −) is considered an ideal radiopharmaceutical for assessing NIS function and iodide organification during thyroid hormone synthesis, due to its gamma emission of 159 KeV resulting in optimal imaging quality.

Imaging

- When I-123 is used, images can be obtained as early as 3–4 hr after radiotracer ingestion. Images obtained at 16–24 hr have the advantage of lower body background, but the disadvantage of a lower count rate. Interpretable images can be obtained as long as 36 hr after ingestion.

- When I-131 is used, images should be obtained at 16–24 hr after radiotracer ingestion.

- **With I-123:**

50,000–100,000 counts or 10 min.

Both anterior oblique images should be obtained for the same amount of time as the anterior image.

The distance between the pinhole aperture and the neck should be adjusted so that the image of the thyroid occupies the central two-thirds of the field of view

Protocol

counts are taken over the thyroid gland and the patient's midthigh for 1 min each at the same distance (i.e., 20–30 cm), taking care to exclude the urinary bladder from the field of view from the detector field. A source of the same radionuclide of identical activity to that given to the patient is placed in a standardized neck phantom and is counted for 1min using the same geometry. The room background is also counted for 1 min

any result in excess of 25 % is compatible with thyroid hyperfunction

- At 6 hours: 3% to 16%
- At 24 hours: 8% to 25%

$$\text{RAIU} = \left(\frac{\text{Patient Neck Counts} - \text{Thigh Counts}}{\text{Phantom counts} - \text{Background Counts}} \right) \times 100$$

- In a small subset of hyperthyroid patients (generally Graves' disease), iodine turnover is rapid that their highest thyroidal uptake is at 6– 12h; however,almost all of these patients maintain an abnormally elevated 24 h and 5 days RAIU
- Elderly patients with hyperthyroidism may have a RAIU value within the normal range (commonly with toxic multinodular goiter)
- In destructive thyroiditis (injury phase) ➡ Low RAIU
- extrathyroidal source of thyroid hormone such as in the presence of ectopic thyroid tissue, exogenous thyroid hormone (factitious thyrotoxicosis) or after iodine contamination (recent IV iodinated radiocontrast administration).
- Functional metastatic thyroid carcinoma and mediastinal goiter ➡ reduced RAIU values.
- Severe renal failure ➡ increased RAIU
- severe stressful illness of any kind ➡ reduce RAIU (euthyroid sick syndrome)

Increased RAIU[a]	Decreased RAIU
TSH-induced hyperthyroidism	Inflammatory thyroid disease
TSH-secreting tumors	Subacute thyroiditis
Selective pituitary resistance to T_4	Painless thyroiditis
Thyroid stimulators other than TSH	Ectopic thyroid tissue
TSAb (Graves' disease)	Struma ovarii
hCG (trophoblastic diseases)	Metastatic follicular carcinoma
Thyroid autonomy	Exogenous sources of thyroid hormone
Toxic adenoma	Medications containing thyroid hormone or iodine
Multinodular goiter	Food sources containing thyroid gland

RAIU testing for detection of intrathyroidal defects of organification (perchlorate discharge test)

- Iodine organification defects (IOD) present with high early uptake sensitive to perchlorate intake. In particular, a reduction>10% of the RAIU levels at 2 h after oral administration of sodium perchlorate is considered positive for an iodide organification defect.
- Patients with iodide discharge of 10 % to 90% are considered to have a partial IOD, whereas patients with iodide discharge greater than 90% are considered to have a total IOD, respectively.

Other radiotracers

- The results of these tests (molecular characterization of FNA) are reported as either benign molecular pattern(no mutations on mutational analysis or a benign GSC (genomic sequencing classifier) or miRNA gene expression classifier result) or suspicious pattern (detection of point mutations in genes that are strongly associated with thyroid cancer,e.g.,BRAF,TERT,andRET/PTC), which require thyroid surgery for definitive diagnosis (estimated risk of malignancy is 37 to 44 %). The negative and positive predictive values of these tests are highly dependent on the prevalence of thyroid cancer in the population that is studied and, particularly, the negative predictive value decreases as the cancer prevalence increases

99mTc-sestamibi scintigraphy for thyroid nodule assessment

- 99mTc-sestamibi is a lipophilic cation that crosses the cell membrane and penetrates reversibly into the cytoplasm via thermodynamic driving forces and then irreversibly passes the mitochondrial membrane along an electrical gradient characterized by a high negative inner membrane potential. The cancer cells, with their greater metabolic turnover, are characterized by a higher electrical gradient of the mitochondrial membrane, leading to increased accumulation of 99mTcsestamibi compared to normal cells

- Continuous iodine excess intake of as little as 1 mg/day for 2 weeks will significantly diminish the radioiodine and 99mTcO4− thyroidal uptake.
- The thyroid uptake of other oncotropic tracers, as 99mTc-sestamibi and 18FDG, is not dependent on NIS expression and activity. Therefore, drugs and substances interfering with iodine uptake do not need to be discontinued before imaging.

- **Instrumentation and image acquisition protocols are the same described for conventional thyroid scintigraphy with 99mTcO4–. Anterior planar images are obtained 10–30 min and 1–2 h after intravenous injection of 99mTc-sestamibi [185–370 MBq].**
- **A SPECT or SPECT/CT can be also obtained in selected cases after reviewing planar images**

1. Molecular thyroid imaging using 99mTc-sestamibi and 18FDG allows evaluation of biological behavior and aggressiveness of hypofunctioning thyroid nodules. In the case of 99mTc-sestamibi-avid and/or 18FDG-avid nodules, the risk of malignancy is about 35 %.

At the same time, a nodule characterized by low or absent 99mTc-sestamibi and/or 18FDG uptake is considered at a very low risk of malignancy.

2, 3. Indeed, the high NPV of thyroid imaging with 99mTcsestamibi or 8FDG is very helpful in characterizing nodules with indeterminate cytological results but also for nodules with repeatedly insufficient and non-diagnostic FNA results

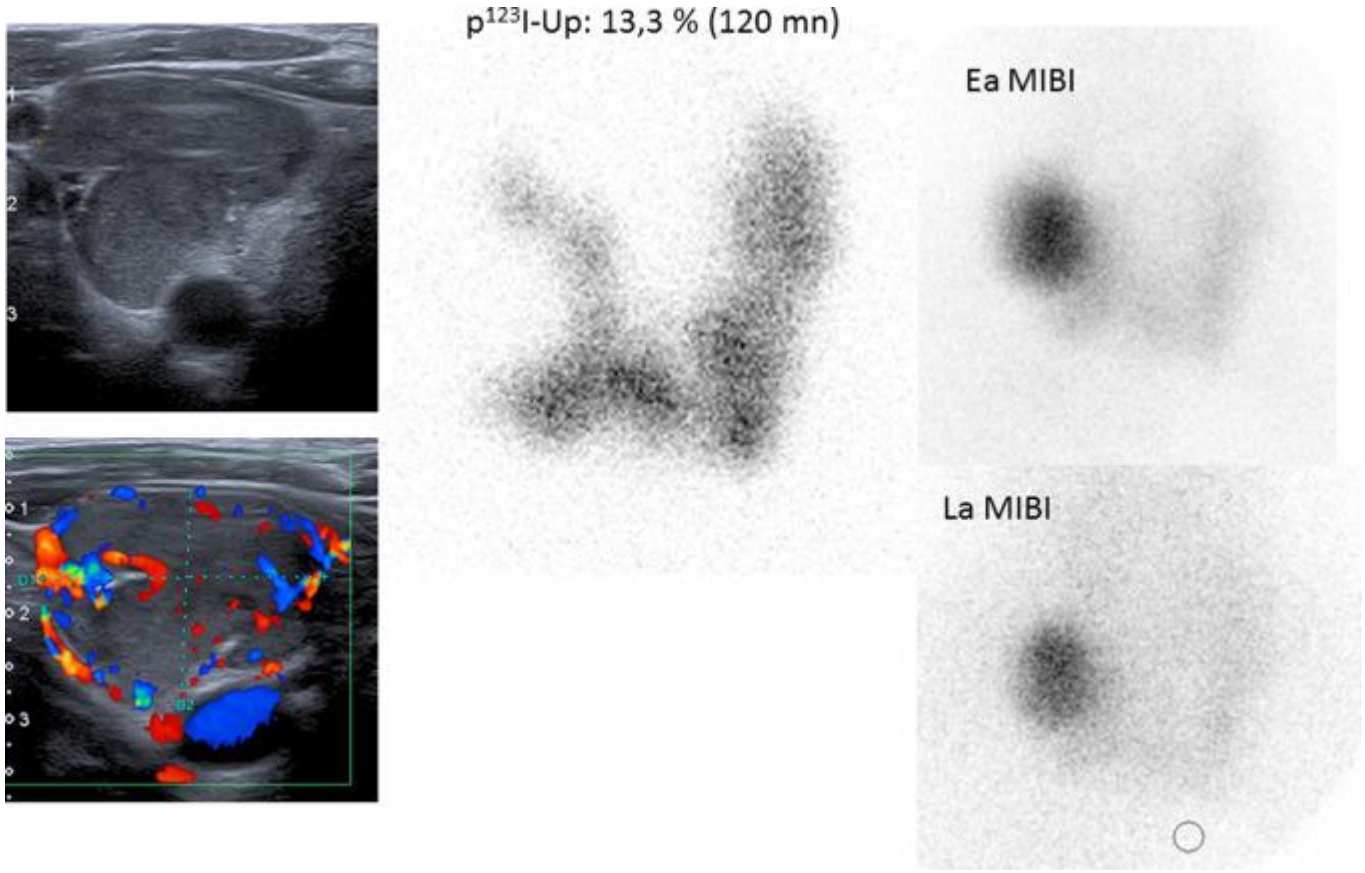
4. Other indications for functional thyroid imaging with 99mTc-sestamibi and/or 18FDG include identification of a nodule at higher risk for malignancy in patients affected by large multinodular goiter, or with multiple nodules with the suspicious of US features for the guiding evaluation with FNA biopsy

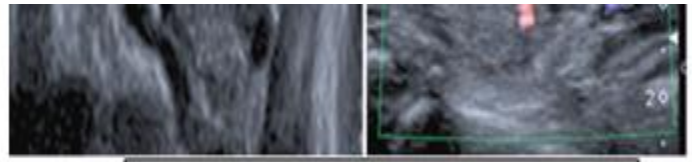
Interpretation

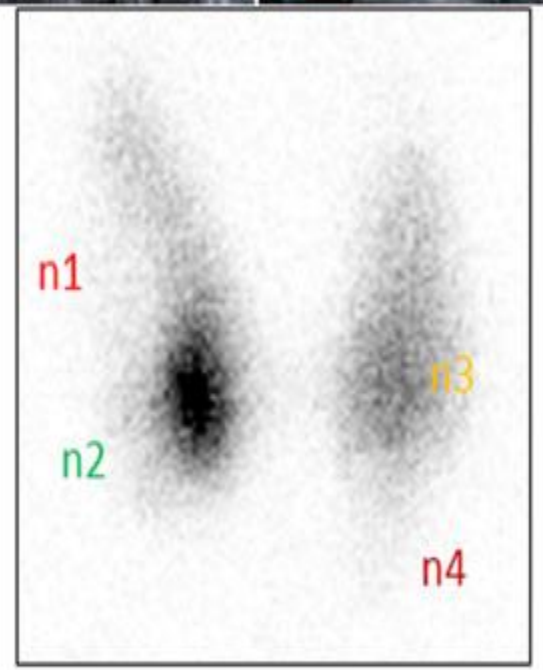
- A “match” between pertechnetate and 99mTcsestamibi scintigraphy is a concordantly decreased uptake in the thyroid nodule in comparison to the normal thyroid gland
- A “mismatch” describes a hypofunctioningthyroid nodule on pertechnetate scintigraphy and an increased uptake of 99mTcsestamib
- An “intermediate finding” describes isointense 99mTc-sestamibi uptake within the nodule in comparison to the paranodular thyroid tissue

One-stop-shop integrated strategy for addressing several clinical questions.
Multinodular toxic goiter (TSH: 0.071 mU/L) in a woman with a right dominant vascularized solid nodule (35 × 25 × 22 mm). First-line FNA displayed a follicular lesion of undetermined significance and numerous smaller nodules, 6 to 12 mm in diameter,

some of them being also vascularized. The Na[^{123}I]I-Up (13.3% at 120 min) is much too high for the TSH stimulation (maximum expected: 20 × 0.071 + 2 = 3.42 << 13.3). The Na[^{123}I]I-TS image depicts multifocal autonomy and a large hypofunctional "cold" right nodule. The [^{99m}Tc]Tc-MIBI scan shows an enhanced [^{99m}Tc]Tc-MIBI Uptake at early (Ea) and late (La) phases, with an abnormal retention index. The therapeutic option was changed to surgery.







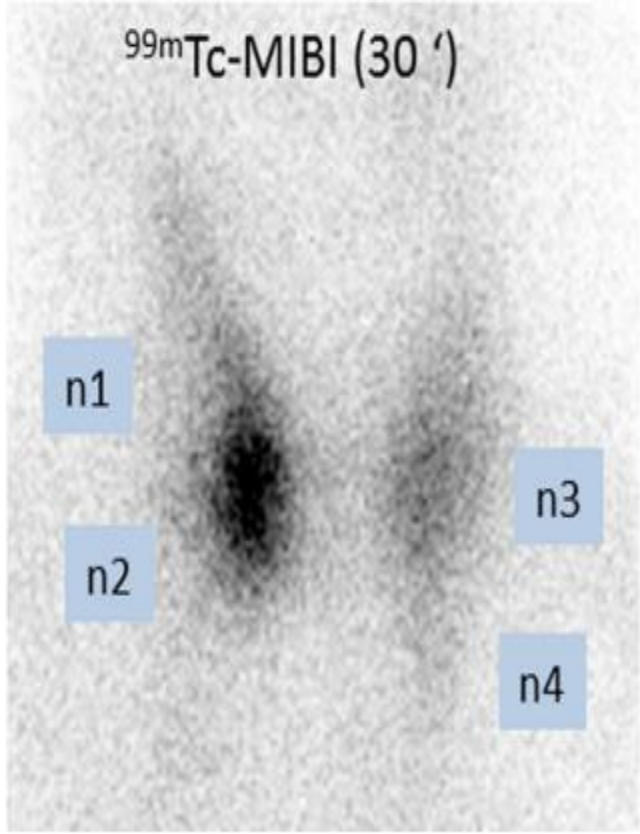


Fig. 6. Correlative multiparametric ultrasound and double tracer thyroid scan in exploring a complex nodular goiter.

Multinodular thyroid (12 ml) in a 65 woman complaining of palpitations. Four nodules are depicted at MPUS which is suggestive of autoimmune thyroiditis. Biochemical testing revealed borderline normal: TSH: 4,45 mU/L, TPOAbs < 9 UI/ml (*N*< 34), TgAbs: 58,1 UI/ml (*N* < 115). Nodule per nodule analysis was performed using the same visit MPUS with correlative Na[^{123}I]I-TS and early [^{99m}Tc]Tc-MIBI TS. EUTIRADS 4 dominant right nodule (n1) has no Uptake on both TS, excluding a hyperplastic (Na[^{123}I]I) or suspicious nodule ([^{99m}Tc]Tc-MIBI). Inferior EUTIRADS 3 nodular cluster (n2) is hyperfunctional (Na[^{123}I]I) suggesting nodular hyperplasia while the [^{99m}Tc]Tc-MIBI pattern is matching. On the left lobe, both nodules are isoor hypofunctioning (Na[^{123}I]I) with no significant [^{99m}Tc]Tc-MIBI Uptake. With a limited 13,3% Uptake for the TSH stimulation, LT4 therapy should be initiated (limited functional secretory reserve).

Amiodarone-induced thyrotoxicosis(AIT)

- Because of high iodine loading from amiodarone therapy, both iodine trapping and organification within the thyroid gland are reduced and the traditional thyroid imaging agents (99mTcO4−, 123I−) are not useful for further characterization of amiodarone induced thyrotoxicosis (AIT) as type1,causedby increased thyroid hormone production due to amiodarone induced iodine oversupply on a background of non-toxic multinodular goiter
- type 2, caused by increased release of thyroid hormones due to amiodarone-induced thyroid gland inflammation, which has management implications. However, this differential diagnosis is possible using 99mTc-sestamibi thyroid scintigraphy, which demonstrates preserved thyroidal 99mTc-sestamibi uptake in type1 AIT, and decreased thyroidal 99mTc-sestamibi uptake in type 2 AIT

Interpretation

- a negative 99mTc-sestamibi scan reliably excluded malignanc

- For semiquantitative analysis a ROI is placed over the thyroid nodule, copied to the contralateral lobe and a background ROI is drawn on early and delayed images

WOInd cutoff 19 %

$$\text{Washout index (WOInd)} = [(\text{delayed uptake ratio}/\text{early uptake ratio}) \times 100] - 100$$

18FDG

- is able to identify and characterize with high accuracy small thyroid nodules(i.e., ≥5mm)
- Healthy thyroid tissue is characterized by a very low 18FDG activity
- Any focal uptake above normal thyroid parenchyma, corresponding to the nodule with cytological indeterminate results, is considered as positive

- No specific SUVmax cut off has been identified. A high SUVmax value increases the risk of malignancy

Radiation Dosimetry for Adults

Radiopharmaceutical	Administered Activity MBq (mCi)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose Equivalent mSv/MBq (rem/mCi)
NaI-123 iodide*	7.5 – 25 p.o. (0.2 – 0.6)	3.2 Thyroid (12.0)	0.11 (0.41)
Tc-99m pertechnetate	75 – 370 i.v. (2 – 10)	0.062 ULI** (0.23)	0.013 (0.048)
NaI-131 iodide*	1.85 – 3.7 p.o. (0.05 – 0.1)	360 Thyroid (1300)	11 (41.0)

* assuming 25% uptake

** ULI – upper large intestine

Radiation Dosimetry for Children (5 year old)

Radiopharmaceutical	Administered Activity MBq/Kg (mCi/Kg)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose Equivalent mSv/MBq (rem/mCi)
NaI-123 iodide*	0.1 – 0.3 p.o. (0.003 – 0.01)	16 Thyroid (59)	0.54 (2.0)
Tc-99m pertechnetate	1.8-9.2 i.v. (0.05 – 0.25)	0.21 ULI** (0.78)	0.04 (0.15)


Thank
You