

# Radiology Team

## Lecture 4 Thyroid and Parathyroid

Edited by :

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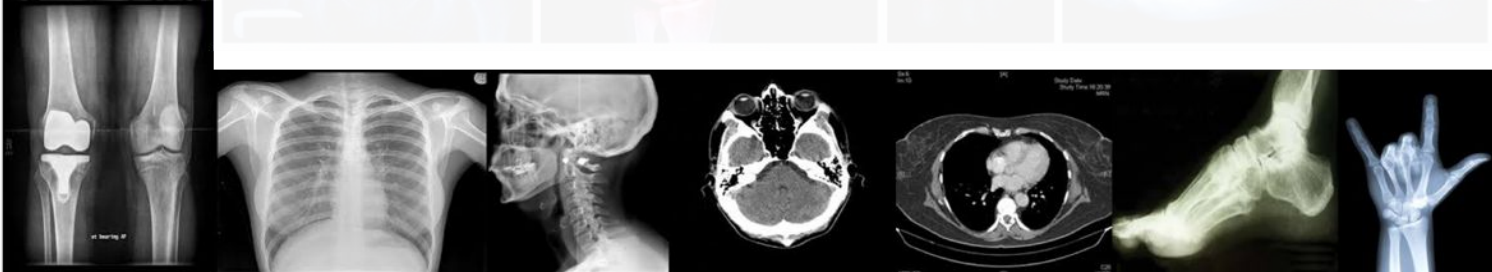
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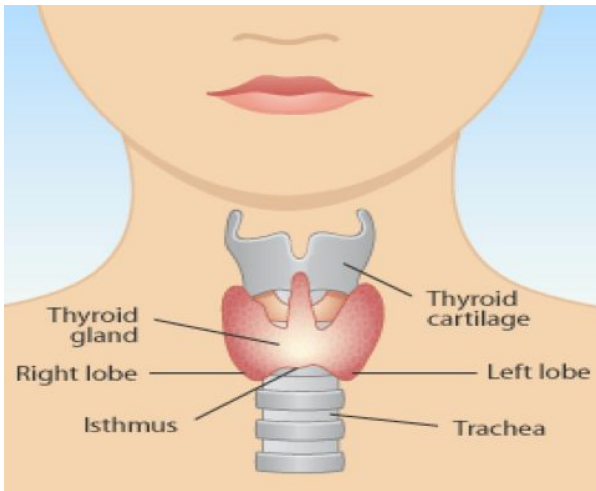
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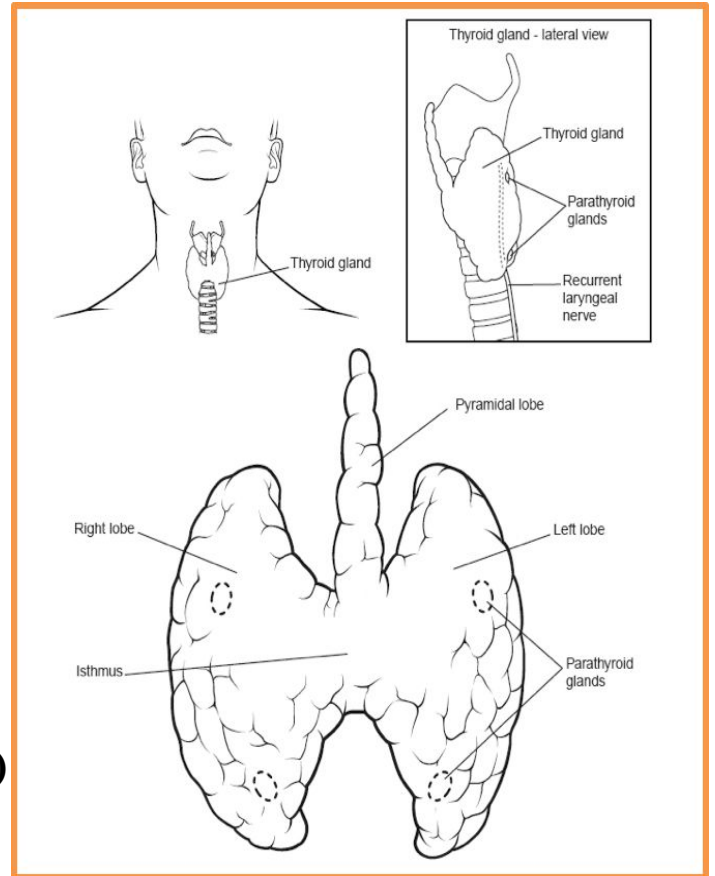
### Color Index:

- **Important**
- **Females' notes**
- **Males' notes**
- **Explanations**
- **433 & 432 Teamwork**

# Anatomy of Thyroid Gland



- ❖ Anterior neck
- ❖ Extending from the level of **C5 - T1**
- ❖ Overlays **2<sup>nd</sup> - 4<sup>th</sup>** tracheal rings
- ❖ Average width: **12-15 mm** (each lobe)
- ❖ Average height: **50-60 mm** long



## Thyroid Disease

### ❖ Thyrotoxicosis Vs Hyperthyroidism :

A group of **symptoms** and signs due to increase production of thyroid hormones.

- **Hyperthyroidism** : Hyper-**functioning** thyroid gland.
- **Thyrotoxicosis** : **Any cause**.

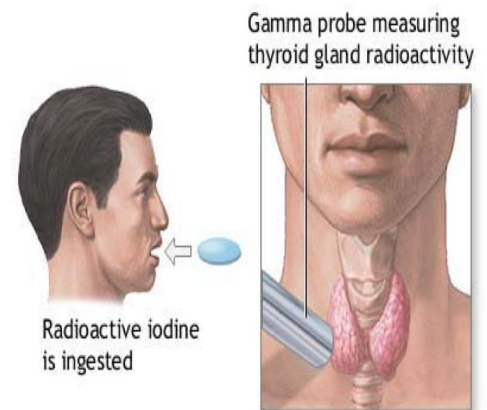
Usually thyroid patient present with lump **عندي انتفاخ** which could be caused by metformin (exogenous cause).

# TFT & Thyroid Scan

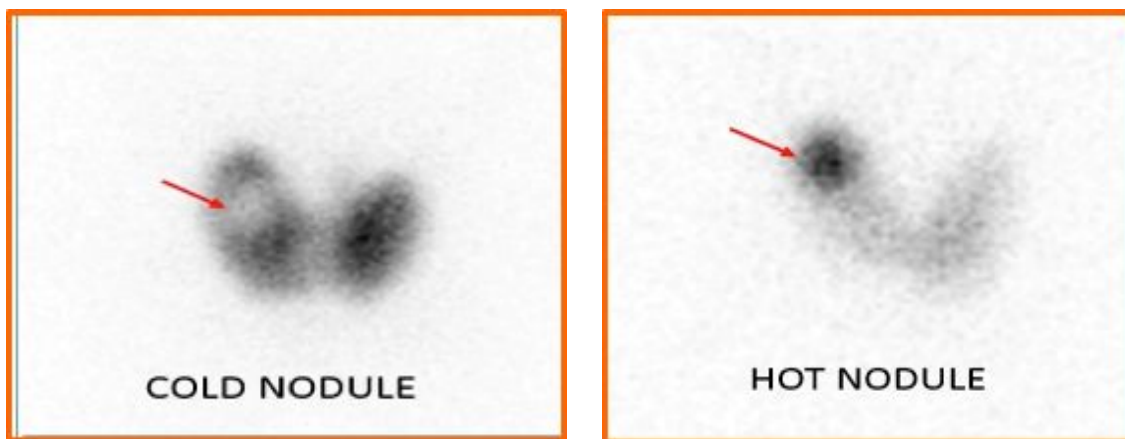
- \* **Thyrotoxicosis** → **suppressed** TSH and **elevated** T3/T4.
- \* Based on TFT (thyroid function test), the exact cause of thyrotoxicosis **can not** be determined.
- \* Thyroid scan is a very helpful tool in **differentiating** between various causes of thyrotoxicosis.

## Thyroid scan and uptake:

- \* **Radioactive Iodine (RAI)** is used for **thyroid scan** and **uptake**.
- \* RAI is given orally.
- \* Image and uptake are obtained after 24 hours
- \* This test determines how much of orally **ingested iodine accumulated in the thyroid at 24 hours**.



ADAM.

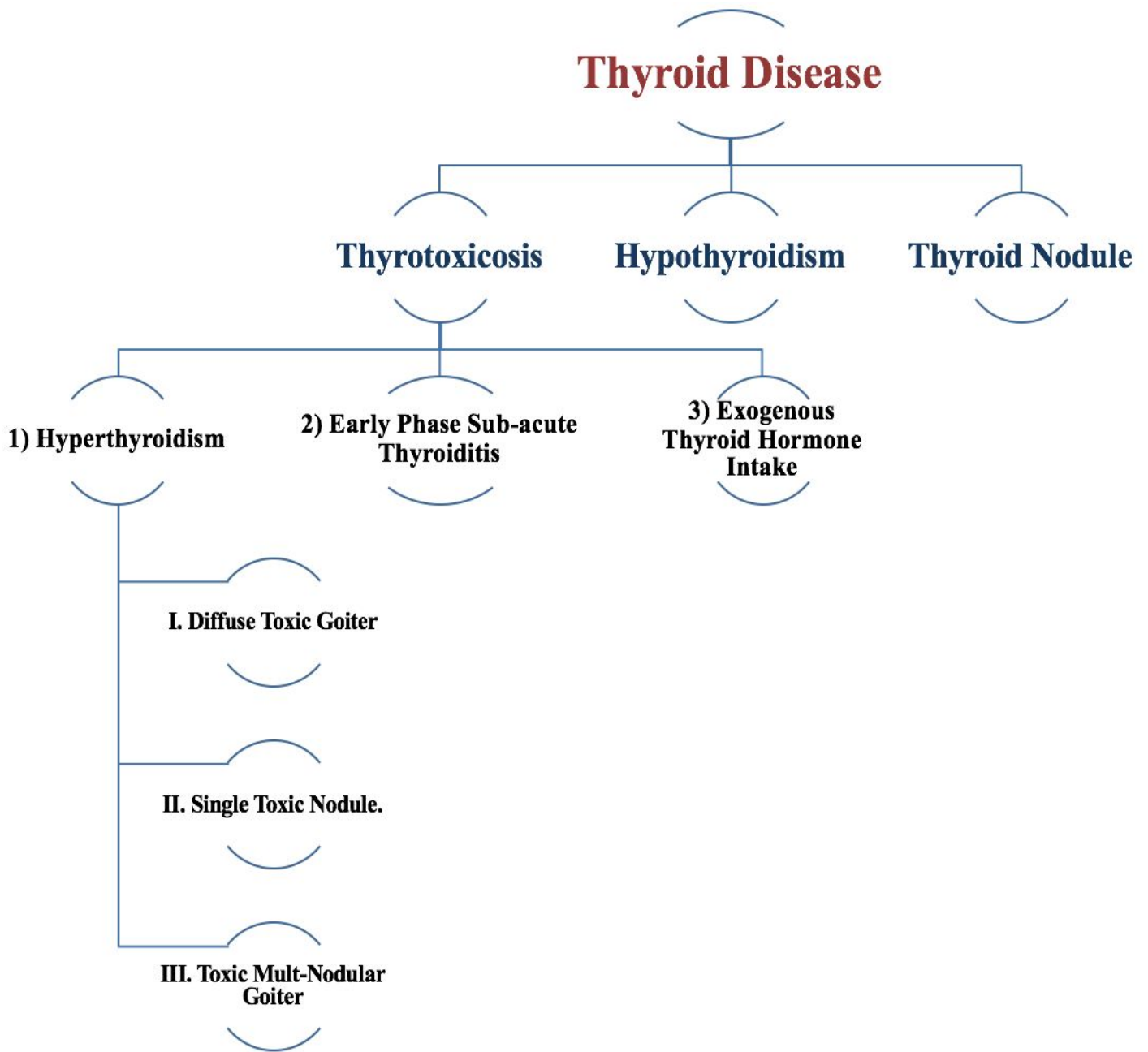


## Imaging Findings :

1. Symmetric or asymmetric uptake.
2. Homogeneous or inhomogeneous uptake.
3. Nodules: Cold or Hot

**If** there is diffuse enlargement it will be treated medically, **If** it is single treated surgically, and you will give the patient radioactive iodine orally and you will scan after 24 hours and this is the usual result either cold nodule (didn't take it) or hot nodule (take it).

# Thyroid Disease

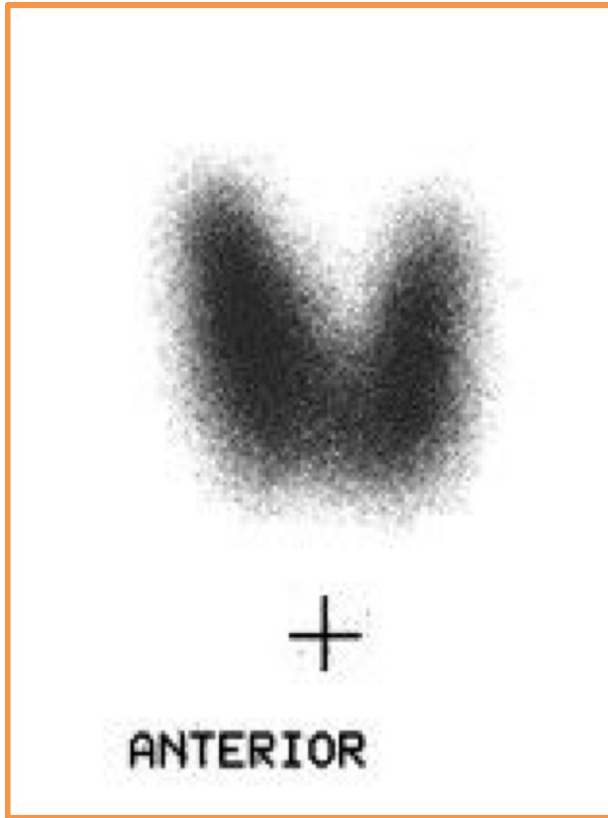


We will talk about it one by one except (Exogenous thyroid hormone intake)

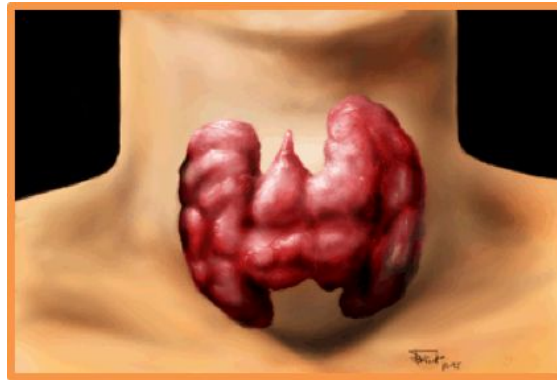
# A. Thyrotoxicosis

## 1) Hyperthyroidism

### I. Diffuse Toxic Goiter (Grave's Disease)



- Diffuse enlargement of thyroid gland.
- **Homogeneous** uptake.
- No significant focal abnormalities (nodules).
- 24-hour RAI uptake is **elevated**, usually > 35%.



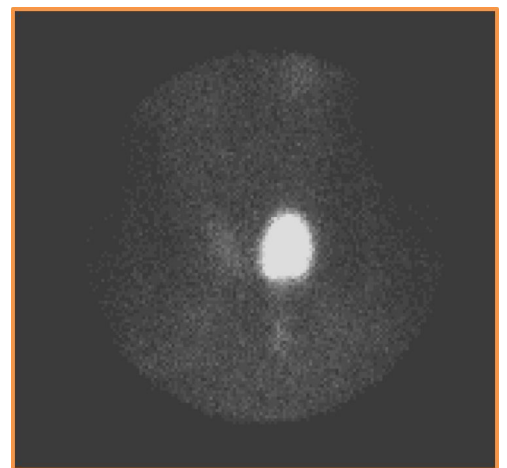
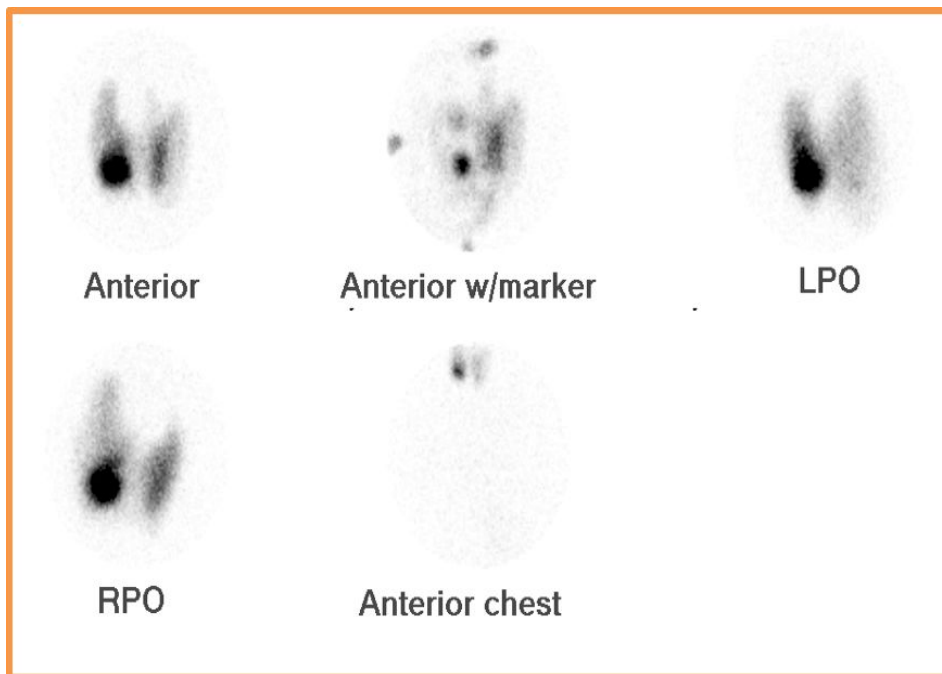
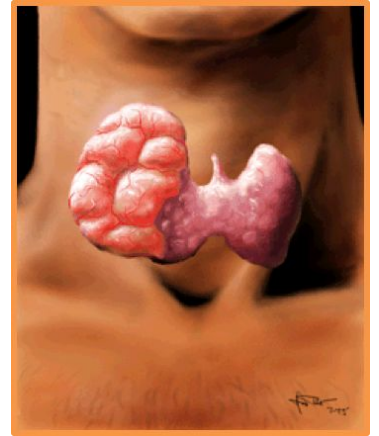
autoimmune disorder

Presence of circulating antibodies directed at TSH receptors; stimulate the receptors excessive thyroid hormone leads to **hyperthyroidism**

- ❖ If you have Graves' disease, you may experience one or more of the following symptoms:
  1. Nervousness.
  2. Irritability.
  3. Difficulty sleeping.
  4. Rapid heartbeat.
  5. Fine tremor of the hands or fingers.
  6. Increased sweating.
  7. Sensitivity to heat.
  8. Sudden weight loss.
  9. Bulging eyes.
  10. Unblinking stare.
  11. Goiter.
  12. light menstrual periods.
  13. Frequent bowel movements.
- ❖ Unrelated tissue manifestations such as *exophthalmos*
- ❖ In Graves' ophthalmopathy, the eyeball protrudes beyond its protective orbit because tissues behind the eye attract and hold water. When this happens, the tissues and muscles swell, causing the eyeball to move forward in the orbit. The front surface of the eye can dry out. Eye symptoms and hyperthyroidism symptoms usually appear within 18 months of each other.
- ❖ sometimes referred to as *diffuse toxic goiter*

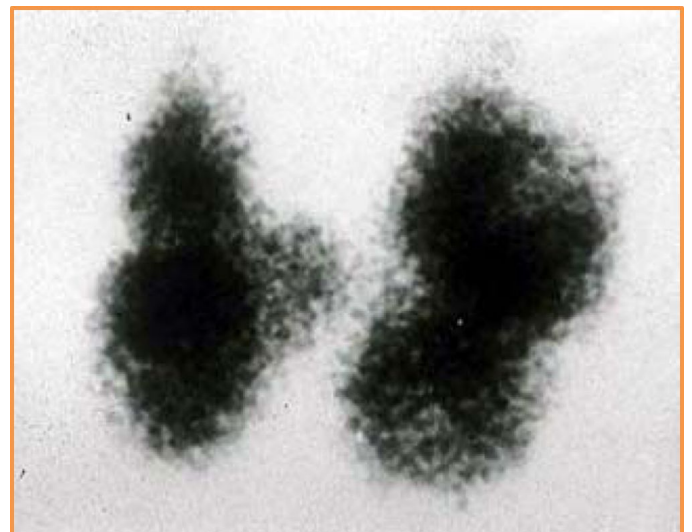
## II. Single Toxic Nodule

- ❑ Single hot nodule (**independent of TSH or autonomous**).
- ❑ Rest of thyroid gland is poorly visualized due to low TSH level (TSH dependent).
- ❑ 24-hour RAI uptake is slightly elevated, usually around 20%.



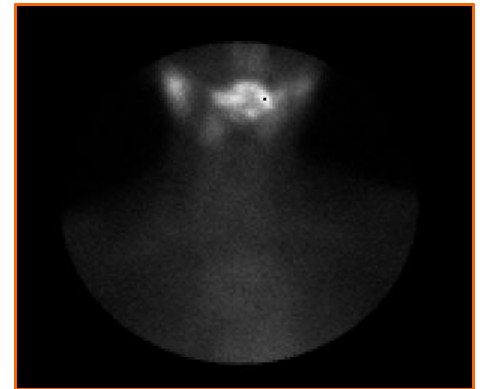
## III. Toxic Multi-Nodular Goiter

- ❑ **Mild inhomogeneous** uptake in thyroid gland.
- ❑ Multiple **cold (Malignant) and hot (Benign) nodules** in both thyroid lobes.
- ❑ 24-hour uptake is **mildly elevated**, usually between 20%-30%.



## 2) Early Phase Sub-acute Thyroiditis

- ✿ **Inhomogeneous uptake** could be mild or severe. In some cases thyroid gland is not visualized.
- ✿ No significant focal abnormalities (nodules).
- ✿ 24-hour RAI uptake is **low**, usually  $< 5\%$   
(Minimal or no uptake at all)

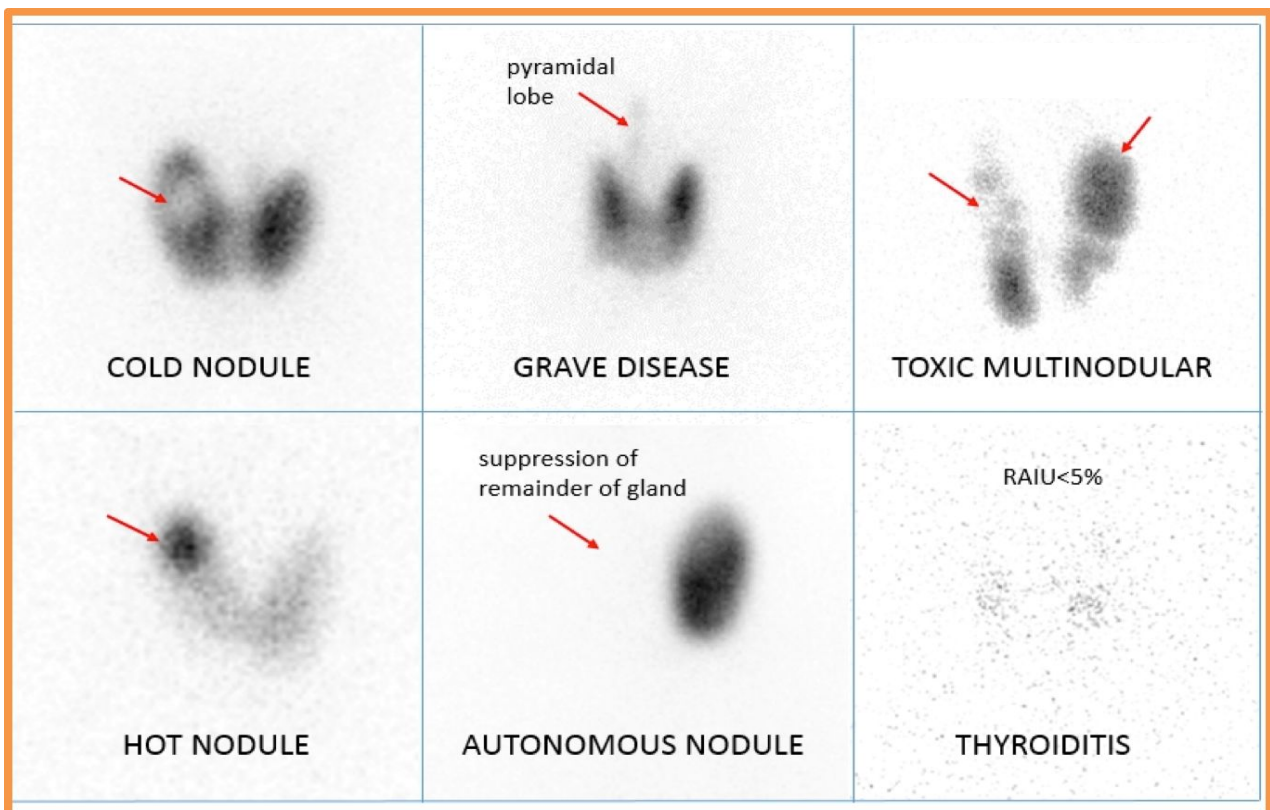


### Little Summary

**Malignancy  
(cold Nodule)**

**Bilateral  
symmetrical uptake  
(No nodule)**

**Cold and Hot  
Nodule together**



**The outline of the thyroid gland is clear with hot nodule**

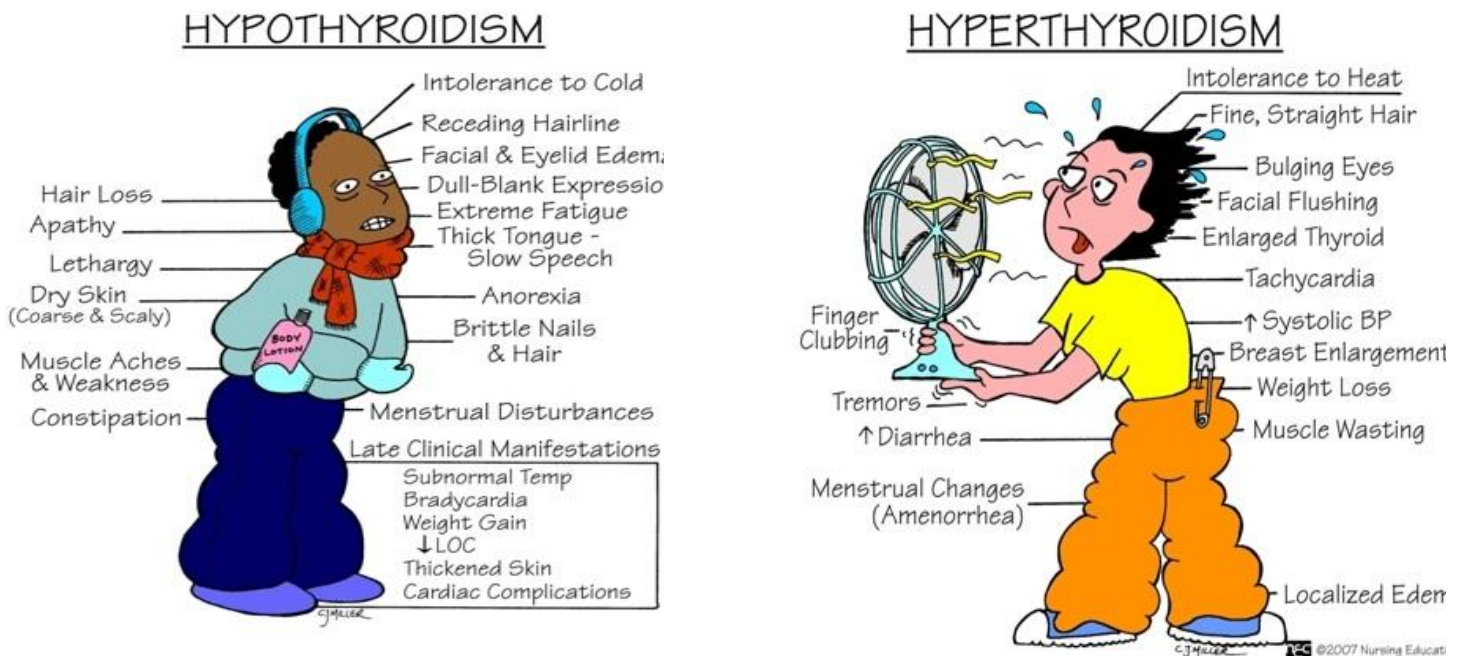
**We can't see the outline of thyroid gland**

**Minimal uptake**

## B. Hypothyroidism

- ❖ The main cause is chronic thyroiditis (**Hashimoto's thyroiditis**).
- ❖ TFT :TSH is **elevated** & **Low** T3/T4
- ❖ Thyroid scan **does not** have significant diagnostic value in this entity. Unless, there is a nodule, thyroid scan may be helpful.

Hypothyroidism patient rarely presenting with reversible dementia.



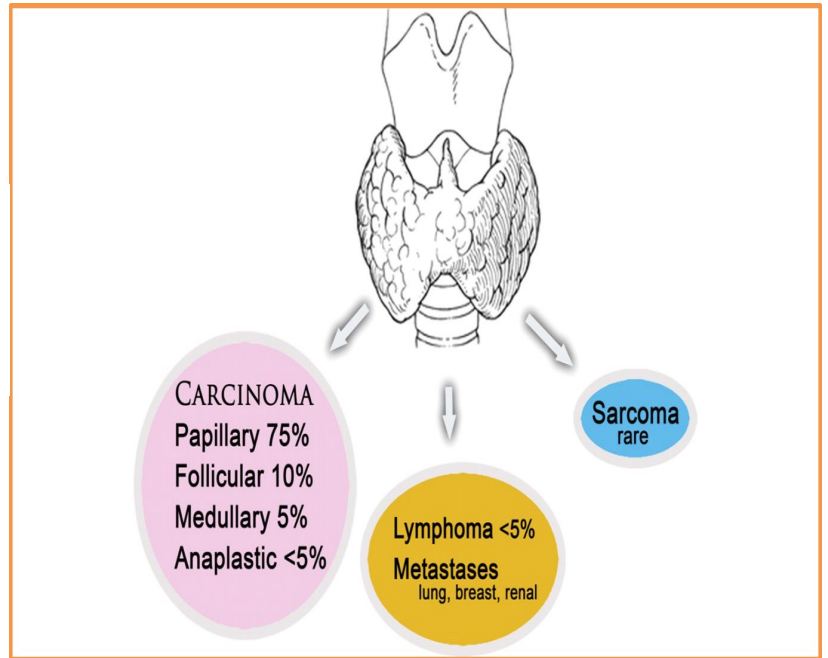
## C. Thyroid Nodule

- ❖ Common, almost existing in half of the population.
- ❖ Usually found by **physical examination** or by **ultrasound**.
- ❖ **US is the first modality used to investigate a palpable thyroid nodule.**
- ❖ **Scintigraphy** (Bone Scan) is reserved for **characterizing** functioning nodules and for staging **follicular** and **papillary carcinomas**.
- ❖ The patient is usually **euthyroid**.
- ❖ If the patient is **hyperthyroid** do nuclear scan otherwise do FNA.
- ❖ **FNA** is the most **accurate** and **cost-effective method** for diagnostic evaluation of thyroid nodules.
- ❖ FNA have a sensitivity of 76%–98%, specificity of 71%–100%



# Frequency of Occurrence of Thyroid Malignancies

- Lymphoma is very rare and sarcoma is extremely rare .
- Papillary and follicular are very common.



From 433

If you have patient with multi-nodular goiter and lab shows euthyroid what is the next step ? US then FNA

If you have patient with multi-nodular goiter and lab shows hyperthyroidism what is the next step ? US then thyroid scan then +/- FNA if need it

So always after TFT do US

## Risk Factors for Thyroid Cancer

1. **Family history** of thyroid cancer.
2. History of head and neck **irradiation**.
3. **Male Gender**.
4. Age of less than 30 years or more than 60 years.
5. Previous diagnosis of **type 2 Multiple Endocrine Neoplasia**

# This Page is very Important

## US Feature of Thyroid Nodules

Certain US features are helpful in **differentiating** between the two. The **malignant features are includes:**

1. Micro-calcifications.
2. Local invasion.
3. A nodule that is taller than it is wider.
4. Markedly reduced echogenicity.
5. Lymph node metastases.

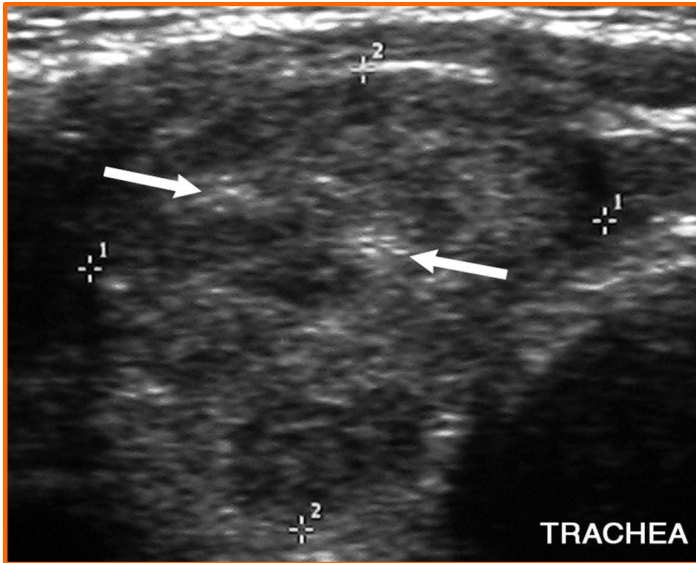
Other **less specific** features of malignant nodules which may be useful, such as:

1. Absence of a halo.
2. defined irregular margins.
3. Solid composition.
4. Vascularity.

### US Features Associated with Thyroid Cancer

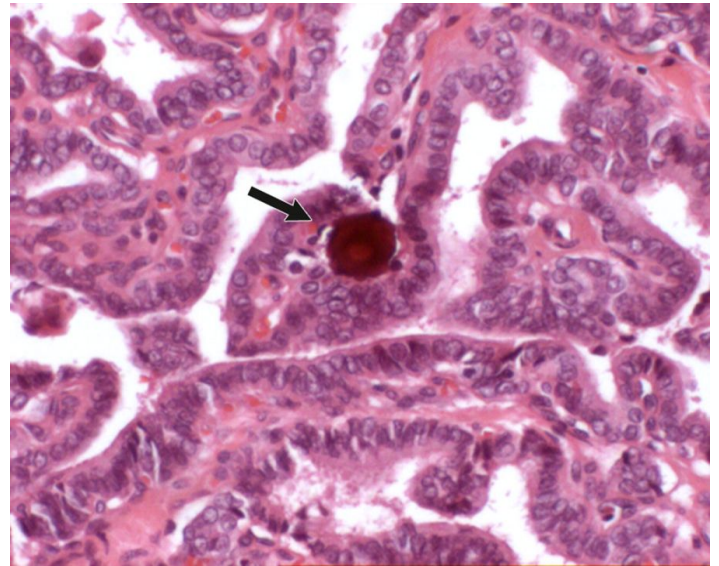
US Feature*	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Microcalcifications (1–5)	26.1–59.1	85.8–95.0	24.3–70.7	41.8–94.2
Hypoechoogenicity (2–5)	26.5–87.1	43.4–94.3	11.4–68.4	73.5–93.8
Irregular margins or no halo (2–5)	17.4–77.5	38.9–85.0	9.3–60.0	38.9–97.8
Solid (4–6)	69.0–75.0	52.5–55.9	15.6–27.0	88.0–92.1
Intranodule vascularity (3, 6)	54.3–74.2	78.6–80.8	24.0–41.9	85.7–97.4
More tall than wide (2)	32.7	92.5	66.7	74.8

## Papillary thyroid carcinoma in a 42-year-old man.



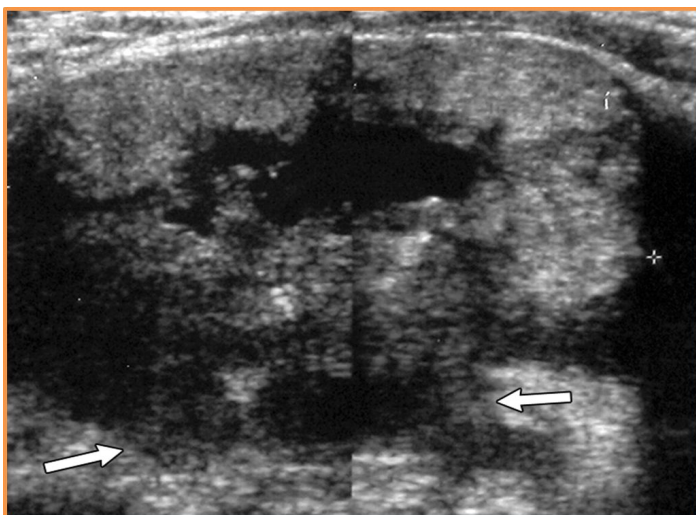
**Transverse sonogram** of the right lobe of the thyroid demonstrates punctate echogenic foci without posterior acoustic shadowing, findings indicative of **microcalcifications** (arrows).

The white arrow is the microcalcification which suggest malignancy

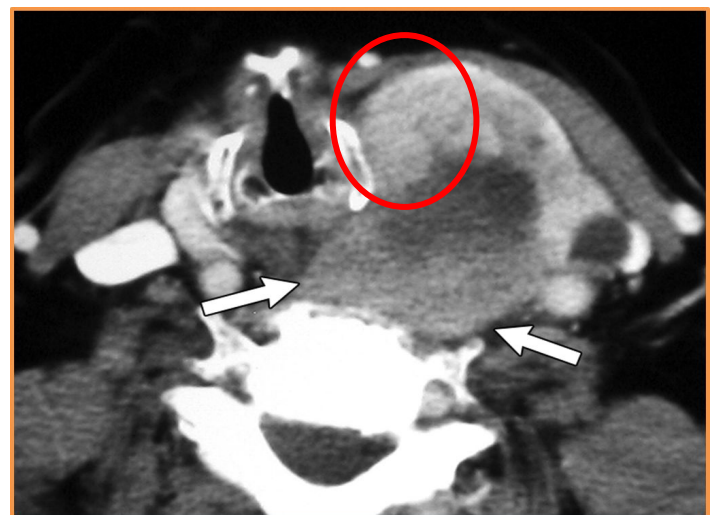


**Photomicrograph** shows a **psammoma body** (arrow), a round laminar crystalline calcification.

## Anaplastic thyroid carcinoma in an 84-year-old woman.



**Transverse sonogram** of the left lobe of the thyroid shows an advanced tumor with infiltrative posterior margins (arrows) and **invasion of prevertebral muscle**



**Axial contrast-enhanced CT image** shows a **large tumor that has invaded the prevertebral muscle** (arrows). **Capsule invasion to prevertebral muscle & Absence of halo** (red circle)

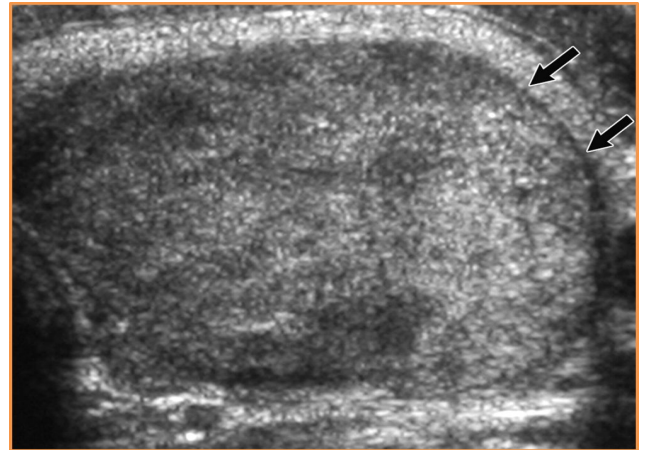
Renal cell carcinoma metastases to the thyroid in a 69-year-old woman.

## Margin & Contour and Shape

A completely uniform halo around a nodule is highly suggestive of **benignity**, with a specificity of 95%

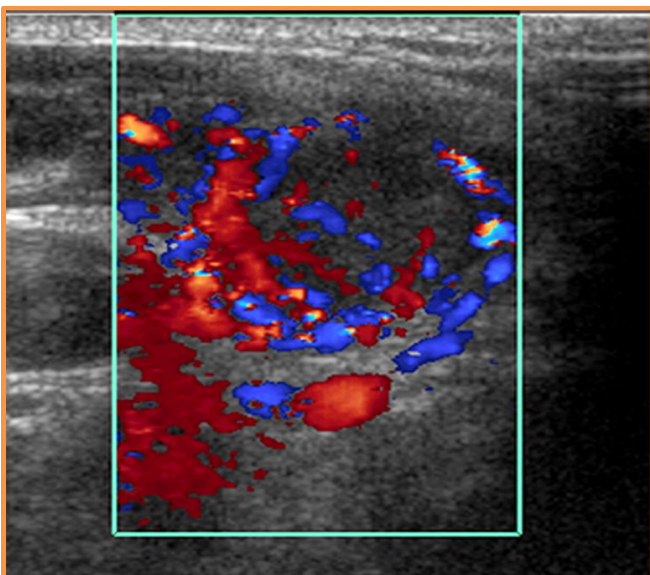
**Follicular adenoma in a 30-year-old woman.**

Present of halo (the arrow) which suggests benign tumor

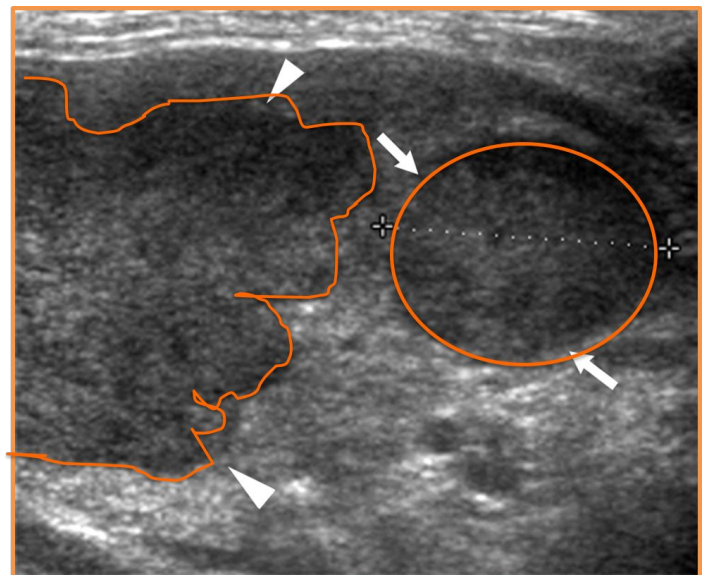


## Vascularity

- ❑ Papillary thyroid carcinomas had some **intrinsic blood flow**
- ❑ **Avascular** nodule is very **unlikely to be malignant**.
  - When vascularity of the nodule within the center it usually considered as a malignant while if it in the periphery it considered as a benign.



**Color Doppler** sonogram of the round nodule shows increased internal vascularity.

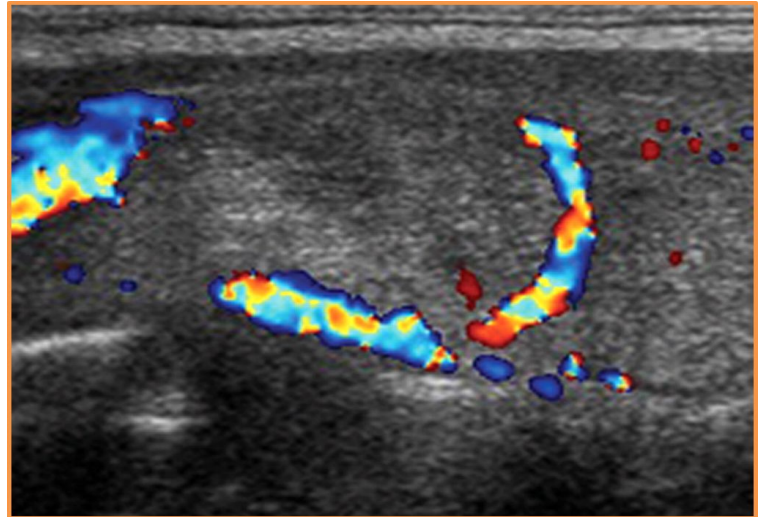


**Longitudinal sonogram** of the right lobe of thyroid shows a round **hypoechoic** (black) nodule (arrows) and an **irregular-shaped hypoechoic nodule**.

## Follicular adenoma in a 36-year-old woman.

**Longitudinal color Doppler sonogram** of the right lobe of the thyroid shows **perinodular flow** around a follicular adenoma.

**Marked hypoechoogenicity** is very suggestive of **malignancy**.



## Hypoechoic Solid Nodule

**B cell lymphoma of the thyroid in a 73-year-old woman with Hashimoto thyroiditis.**

### Benign

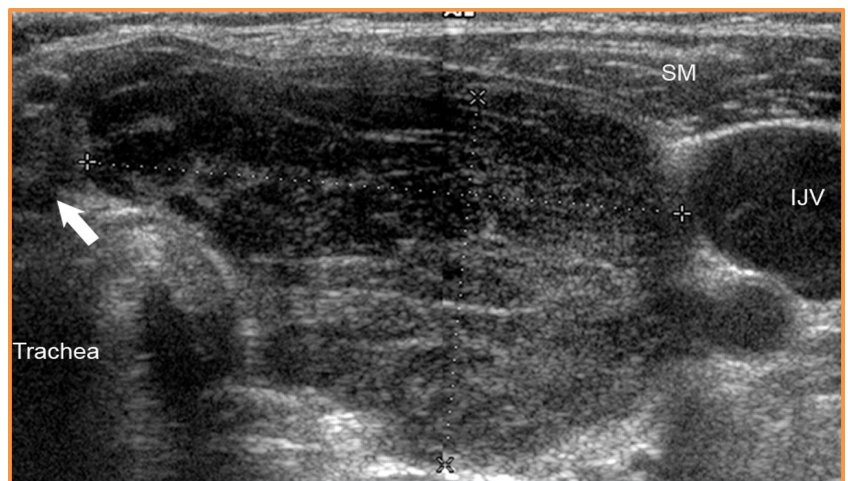
**Hyper-echoic:** Presence of halo

➤ Avascularity

### Malignant

**Hypo-echoogenicity:** Absent of halo

➤ Increase vascularity.



Transverse sonogram of the left lobe of the thyroid shows a large heterogeneous mass (between calipers) with marked hypoechoogenicity when compared with the strap muscles (SM). A normal isthmus (arrow) also is visible. IJV = internal jugular vein.

# Non Specific US Features

- ❑ **The size** of a nodule is **not helpful** for predicting or excluding malignancy.
- ❑ There is a common but mistaken practice of selecting the largest nodule in a multinodular thyroid for FNA.

## Interval Growth of a Nodule

- ❑ In general, interval growth of a thyroid nodule is a **poor indicator of malignancy**. Benign thyroid nodules may change in size and appearance over time.
- ❑ The exception is clinically detectable rapid interval growth, which most commonly occurs in **anaplastic thyroid carcinoma** but also may occur in lymphoma, sarcoma, and, occasionally, high-grade carcinoma.

## ● Number of Nodules

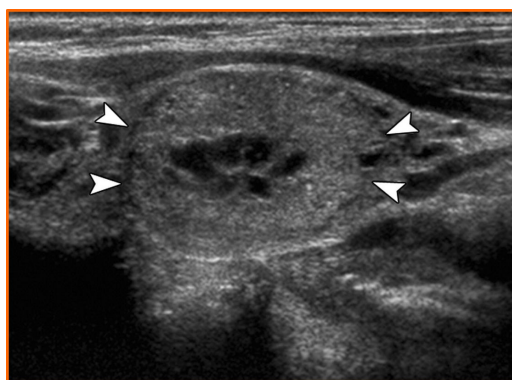
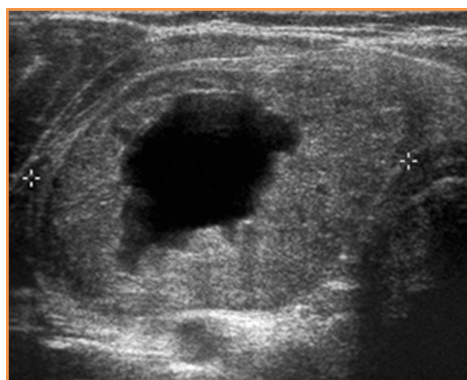
Although most patients with nodular hyperplasia have multiple thyroid nodules and some patients with thyroid carcinoma have solitary nodules, the presence of multiple nodules should never be dismissed as a sign of benignity.

US Feature	Recommendation
Solitary nodule	
Microcalcifications	Strongly consider US-guided FNA if $\geq 1$ cm
Solid (or almost entirely solid) or coarse calcifications	Strongly consider US-guided FNA if $\geq 1.5$ cm
Mixed solid and cystic or almost entirely cystic with solid mural component	Consider US-guided FNA if $\geq 2$ cm
None of the above but substantial growth since prior US examination	Consider US-guided FNA
Almost entirely cystic and none of the above and no substantial growth (or no prior US)	US-guided FNA probably unnecessary
Multiple nodules	Consider US-guided FNA of one or more nodules, with selection prioritized on basis of criteria (in order listed) for solitary nodule*

Here the idea → it's recommended that when doctor do US and find microcalcification more than 1cm he should do FNA.

## Doctor go through it quickly

US images of thyroid nodules of varying parenchymal composition (solid to cystic).



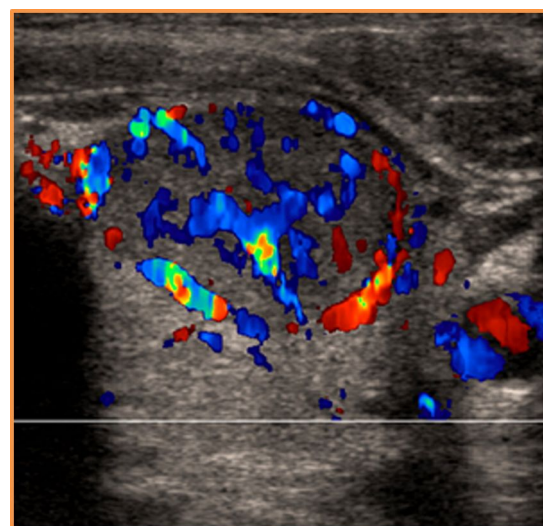
Presence of halo suggest benign tumor

- ❖ Sagittal image of solid nodule (arrowheads), which proved to be papillary carcinoma.
- ❖ Sagittal image of predominantly solid nodule (arrowheads), which proved to be benign at cytologic examination.
- ❖ Transverse image of mixed solid and cystic nodule (calipers), which proved to be benign at cytologic examination.
- ❖ Sagittal image of predominantly cystic nodule (calipers), which proved to be benign at cytologic examination.
- ❖ Sagittal image of cystic nodule (arrowheads). FNA of this presumed benign lesion was not performed because the nodule appears entirely cystic.

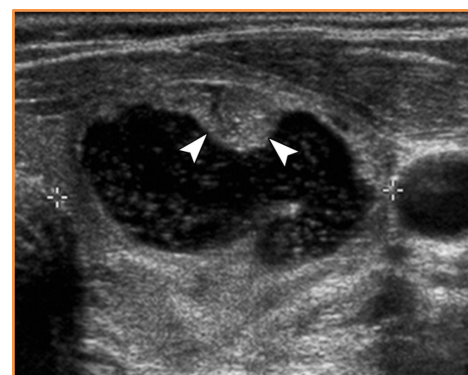
### Vascularity suggest malignant

- ❖ Transverse gray-scale image of predominantly solid thyroid nodule (calipers).
- ❖ Addition of color Doppler mode shows marked internal vascularity, indicating increased likelihood that nodule is malignant. This was a papillary carcinoma.

Predominantly solid thyroid nodule.



- ❖ Gray-scale image shows predominantly cystic nodule (calipers) with small solid-appearing mural component (arrowheads).
- ❖ Addition of color Doppler mode demonstrates flow within mural component (arrowheads), confirming that it is tissue and not debris. US-guided FNA can be directed into this area. The lesion was benign at cytologic examination.



cystic nodule with small solid-appearing mural component

# US Features of Malignant Lymph Nodes

**Rounded Bulging Shape**

**Replaced Fatty Hilum.**

Calcifications

Vascularity throughout the lymph node instead of normal central hilar vessels at Doppler imaging

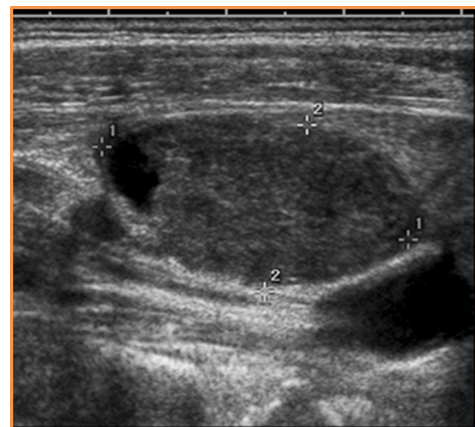
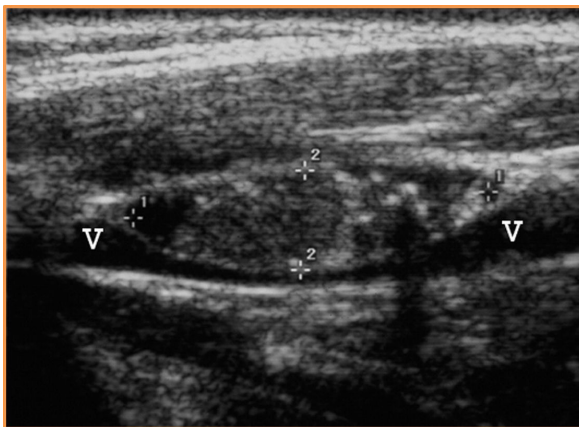
**Increased Size.**

Heterogeneous Echotexture.

Cystic Areas

**Irregular Margins**

## Abnormal cervical lymph nodes.

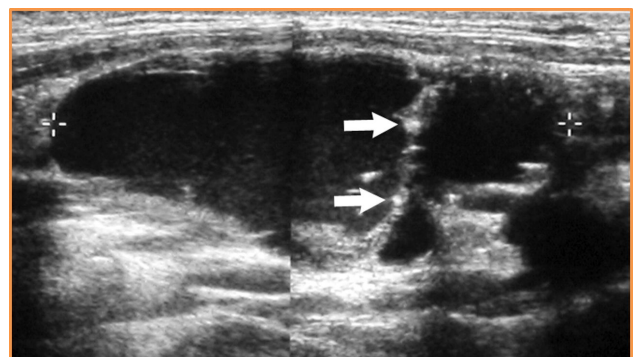


**Metastatic papillary carcinoma in lymph node because they are wider and absence of internal hilum**

## Papillary carcinoma and cystic lymph node metastasis in a 28-year-old woman.

Show irregular hypoechoic tumor and microcalcification, the arrows refer to foci microcalcification

**If there is cystic it is another indication for malignant**





# US-Guided FNA Technique

The needle may be introduced parallel or perpendicular to the transducer, and the needle tip should be carefully monitored during the procedure.

## Thyroid Ophthalmopathy (Graves' Disease)

### Clinical history:

**Slow onset** (months), **painless** exophthalmos.

### Patterns of muscle involvement in thyroid ophthalmopathy:

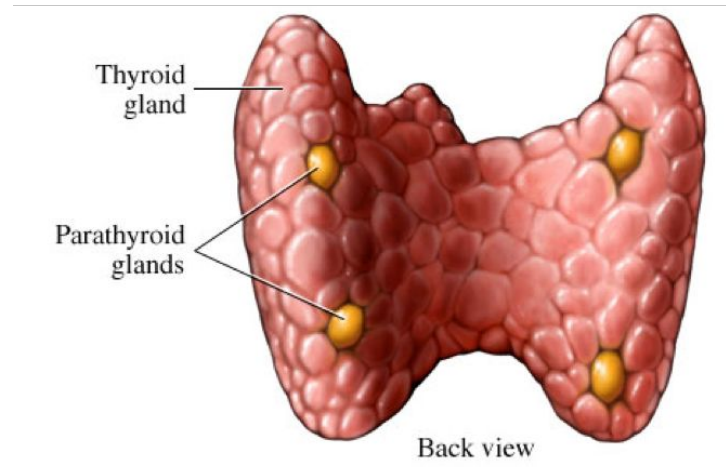
1. **Bilateral (85%)**
2. **Unilateral (5%)**
3. **Normal muscles (10%)**
  - ❑ All muscles involved is most common scenario of extraocular muscle enlargement.
  - ❑ If only individual muscles involved, commonly **Inferior** then **Medial recti muscles**
  - ❑ **Lateral rectus muscle**: last to become involved; rarely/never the only muscle involved
  - ❑ **I'M SLOW** ( Inferior, Medial, Superior , Lateral)
  - ❑ Muscle enlargement characteristically involves the body of the muscle, sparing the tendinous attachment to the globe.
  - ❑ Patients need not be hyperthyroid (some are euthyroid).
  - ❑ **Coronal imaging** is the method of choice for assessing muscle thickness



1. **Exophthalmos protrusion.**
2. **Enlargement of muscle.**
3. **Abundant of retrobulbar fat.**
4. **Herniation of the fat through superior orbital fissure .**
5. **There impression of lamina papyracea medially.**
6. **Stretching of optic nerve.**
7. **The disease is bilateral.**

# Parathyroid Gland

- ❖ Two pairs of glands usually positioned behind the left and right lobes of the thyroid.
- ❖ Typically 4 parathyroid glands (Superior and Inferior ) parathyroid glands.



## Renal Osteodystrophy

Seen in setting of chronic, **end-stage renal disease**.

**Related to combination of :**

1. **Osteomalacia.**
2. **Secondary hyperparathyroidism**

**Features :**

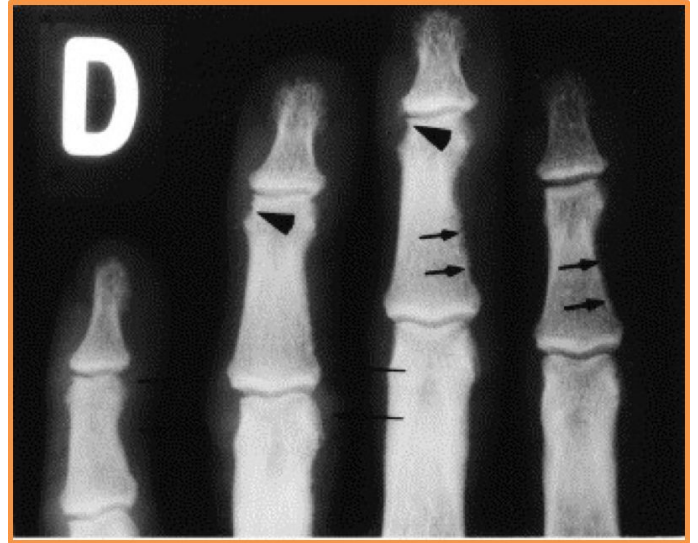
1. **Bone resorption** mainly (Sub-periosteal)
2. Cortical thinning.
3. Soft tissue and vascular calcifications
4. Osteosclerosis
5. **Brown tumors.** (seen in primary rather in secondary)

- ★ **Osteopenia** is most common finding; however, **10-20%** of patients also **exhibit osteosclerosis.**
- ★ Characteristic finding of osteosclerosis is **"Rugger jersey spine"** اسود ابيض, اسود ابيض
- ★ Bands of hazy sclerosis that parallels the vertebral body endplates.
- ★ Both axial and appendicular skeleton involved.
- ★ Increased risk for **pathologic fracture.**



Typical **subperiosteal** bone resorption at the **radial aspects of the middle phalanges with bone resorption** at the margins of the distal interphalangeal joints.

Typical feature of secondary parathyroid in the setting of renal osteodystrophy. There will be scalloping, irregularity periosteal.



**Cortical thinning**



**Rugger jersey spine**



**Brown tumor**



# Summary (from doctor mouth)

Home message you will deal with **Benign** or **Malignant** nodule the patient will come complain of swelling

## What is the Difference between thyrotoxicosis and hyperthyroidism ?

thyrotoxicosis is group of symptoms & signs because of increased production of thyroid hormones. Hyperthyroidism = hyper function

1. Mental disturbance.
2. Sweating.
3. Palpitation.
4. Irregular menstruation.
5. Weight loss.
6. Diarrhea.

## What is the first modality of investigation?

### Ultrasound

#### why ?

1. Easy.
2. Non invasive
3. Accesible
4. No radiation
5. Because the thyroid is superficial .

## The doctor aim :

1. Are dealing with hyperthyroidism or not.
2. Then localize the lesion is it within the thyroid
3. What are the causes of hyperthyroidism.

## Hypothyroidism

1. Common.
2. Above >50 usually.
3. Patient came with disturbance of mental states rarely with dementia.
4. Constipation.

- Cold nodule** mean didn't uptake (ما اخذت)
- Hot nodule** mean uptake (اخذت)

- Lymphoma is very rare and sarcoma is extremely rare .
- Papillary and follicular are very common.

## Patient present with diarrhea, palpitation, sweating ? what will you do ?

→ Order TSH.

### This is the usual result :

→ TSH will be low

→ T3 and T4 will be increased

- Now you know this patient has thyrotoxicosis and now you should **localize** the origin so if it
- Diffuse enlargement treatment will be **medical**.
- Single nodule treatment will be **surgical**.

## Choose the correct answer

**1)A 35 year old female presents with advanced SLE. The following x-ray represents:**

- A)Renal osteodystrophy
- B)Multiple myeloma
- C)Vertebral body collapse due to metastasis
- D)The most likely diagnosis is TB of the spine because the patient is immunocompromised

**2)A female patient came to the clinic with enlarged thyroid. She mentioned that she has been eating and sweating a lot lately, and been feeling tired in the past weeks. What's her diagnosis according to the nuclear scan?**

- A)Grave's disease
- B) Sub-acute thyroiditis
- C) Hashimoto disease
- D) Toxic multinodular goiter

**3)The nuclear scan type that's used for parathyroid is ?**

- A) TC99 Sestambi.
- B) TC99 MDP
- C) I123.
- D) I131.