RADIOLOGY
TEAM 435

Radiology of thyroid & parathyroid

[Color index: Important | Notes | Extra | Editing file]

- **Objectives:**
  - not given

- **Resources:**
  - doctor's slide
  - 434 & 433 team

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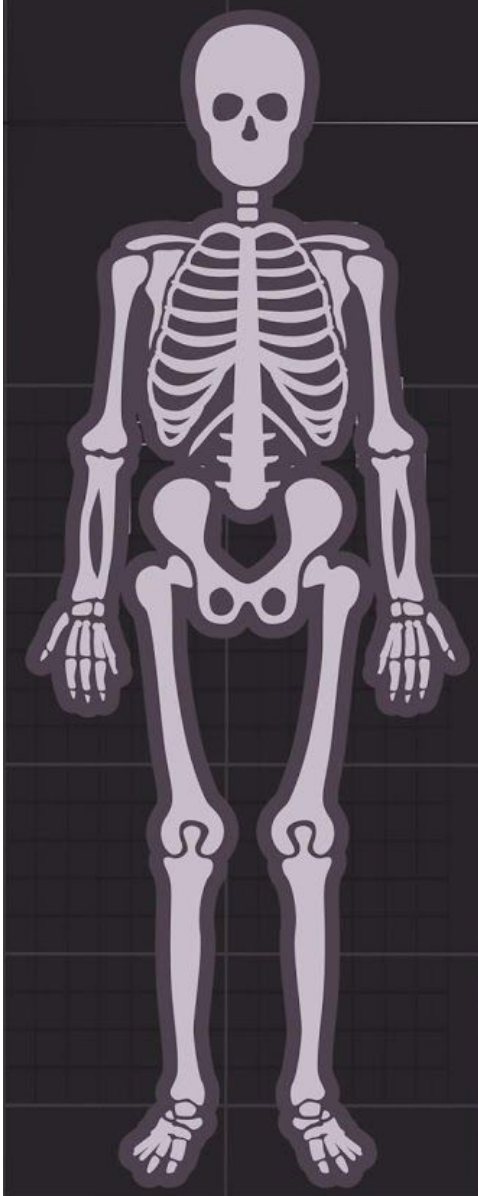
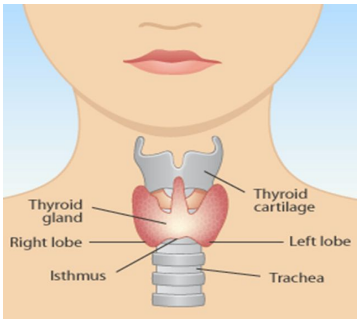
434 summary + MCQ

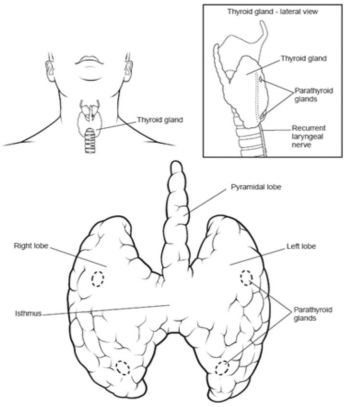


Introduction

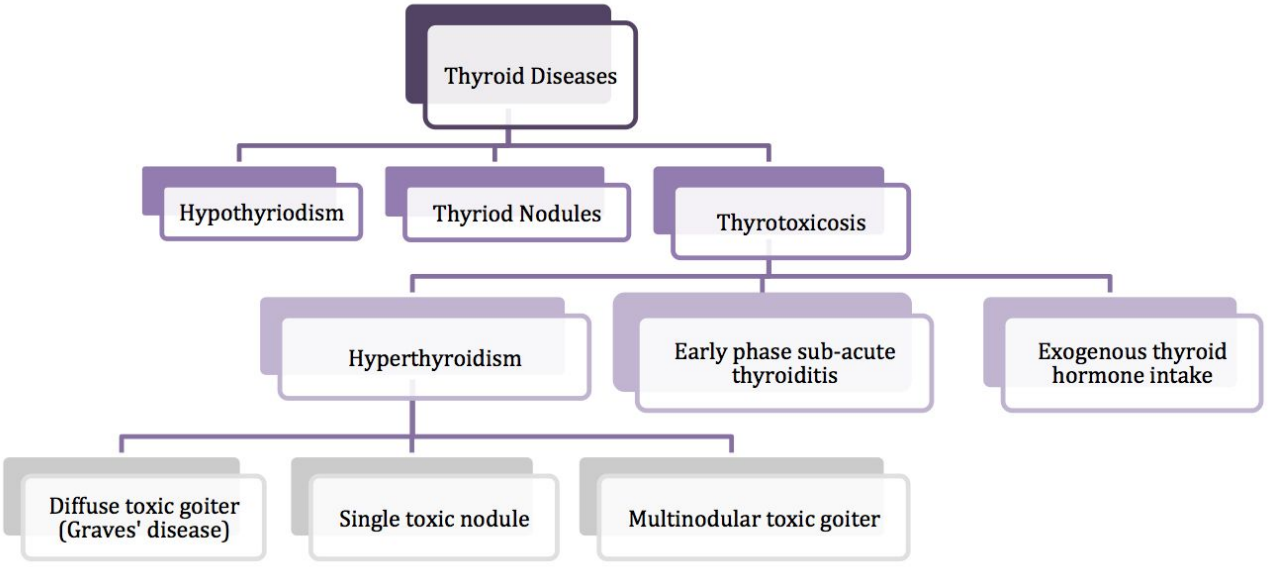
❖ Anatomy of the Thyroid Gland:

- Anterior neck
- Extending from the level of C5 - T1
- Overlays 2nd – 4th 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.

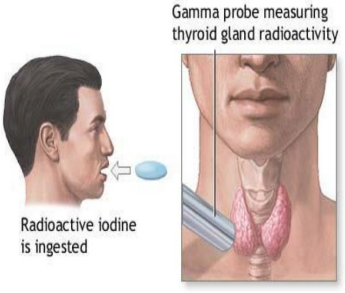
- Hyperthyroidism : Hyper-functioning thyroid gland.
- Thyrotoxicosis : Any cause.

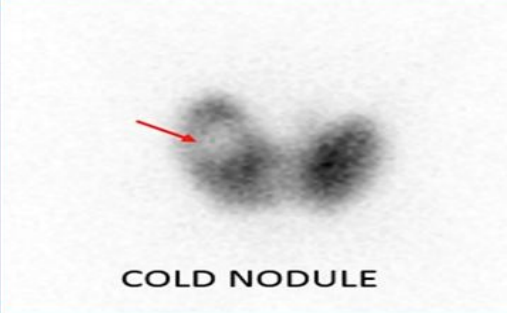
❖ TFT & Thyroid Scan:

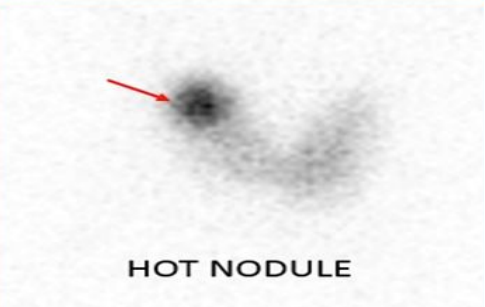
- Thyrotoxicosis ⟶ suppressed TSH and elevated T3/T4.
- Based on TFT (thyroid function test), the exact cause of thyrotoxicosis can not be determined.
- Thyroid scan is a very helpful tool in differentiating between various causes of thyrotoxicosis.

❖ Thyroid scan and uptake:

- Radioactive Iodine (RAI) is used for thyroid **scan** and **uptake** ⟶ it's 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.
- Imaging Findings:
    1. Symmetric or asymmetric uptake.
    2. Homogeneous or inhomogeneous uptake.
    3. Nodules: Cold or Hot.





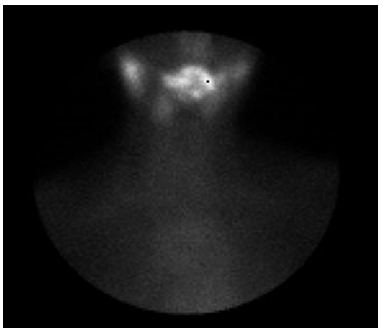


If there is diffuse enlargement it will be treated medically, If it is single it will be treated surgically, and you will give the patient radioactive iodine orally then scan after 24 hours and the usual results are either cold nodule **(didn't take it)** or hot nodule **(take it).**

Thyrotoxicosis

1) Exogenous thyroid hormone intake.

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%.

2) Hyperthyroidism

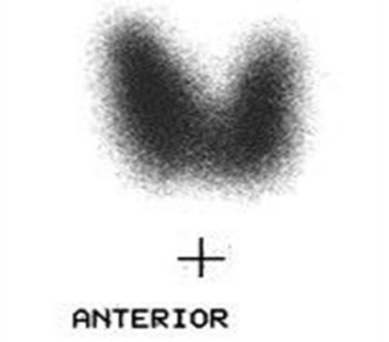
I. Diffuse Toxic Goiter (Graves' Disease)

- 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 which leads to excessive thyroid hormones and 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. Heat intolerance
8. Sudden weight loss.
9. Bulging eyes.
10. Unblinking stare.
11. Goiter.
12. Light menstrual periods.
13. Frequent bowel movements.



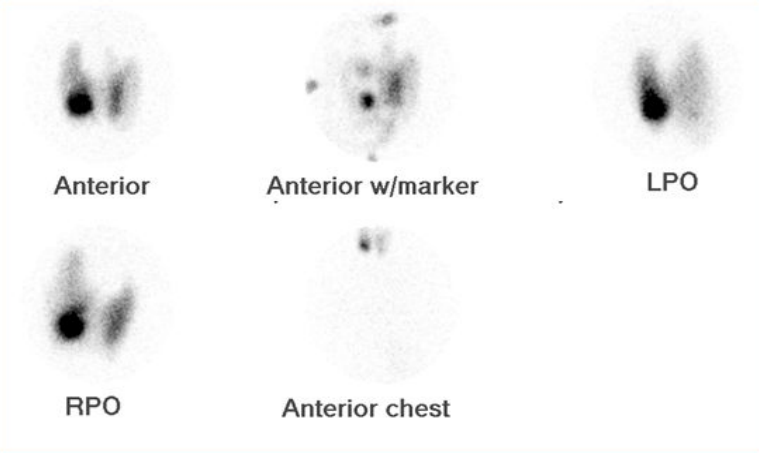
❖ Unrelated tissue manifestations such as ***exophthalmos***

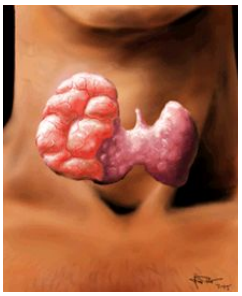
❖ In Graves' ophthalmopathy, the eyeball protrudes beyond its protective orbit because tissues behind the eye attract and hold water. When this happens, the tissues and muscles swell, causing the eyeball to move forward in the orbit. The front surface of the eye can dry out. Eye symptoms and hyperthyroidism symptoms usually appear within 18 months of each other.

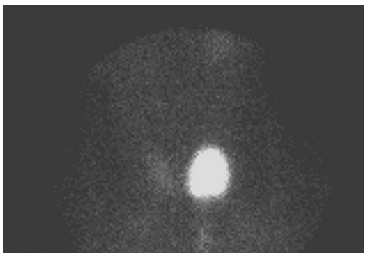
❖ sometimes referred to as ***diffuse toxic goiter.***

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%.







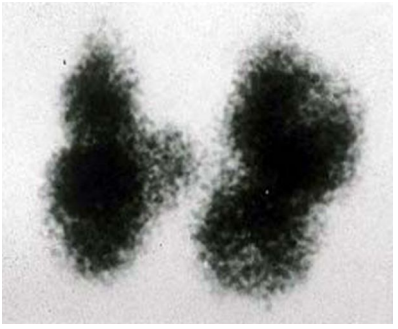
Toxic (Hot) Nodule

RPO: Right posterior oblique**, LPO:** Left posterior oblique.

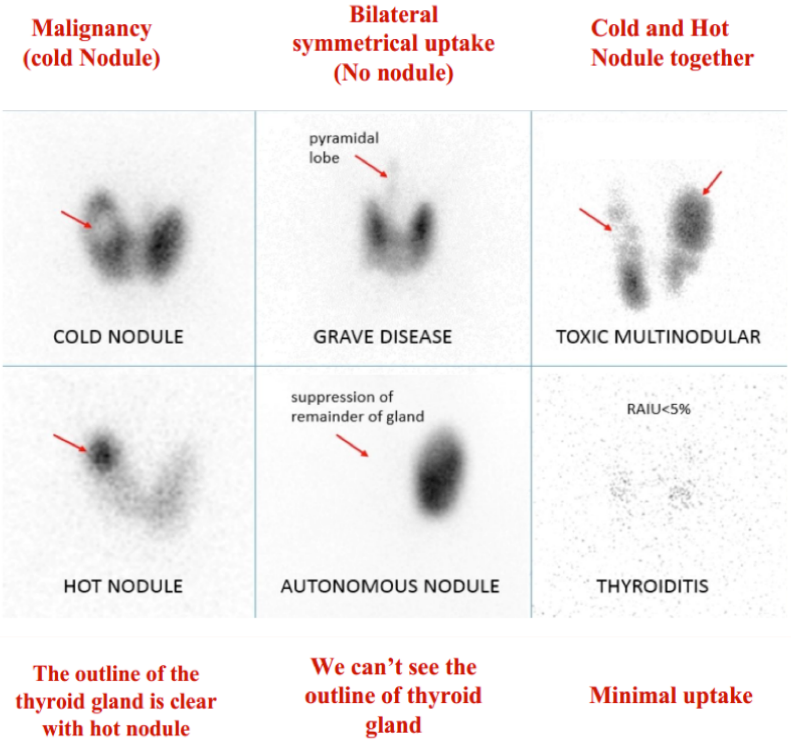
III. Toxic Multi-Nodular Goiter

- 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%.

Asymmetric, functioning

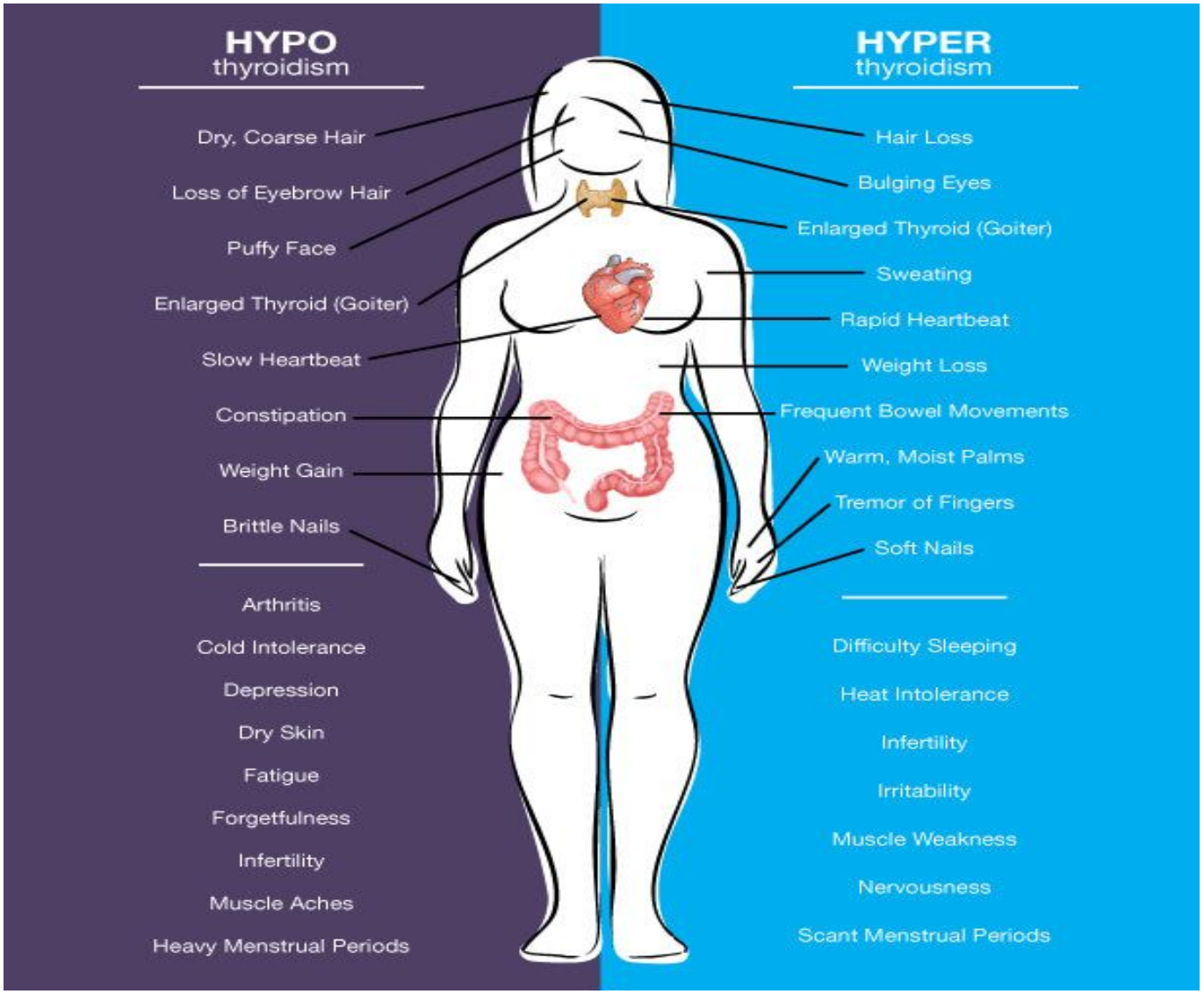


❖ Summary:



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.

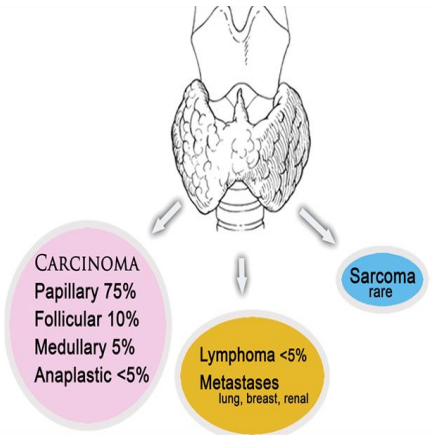


Thyroid nodules

- 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.→ (important)
- Scintigraphy (thyroid 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 a patient with multi-nodular goiter and lab shows euthyroid, what is the next step ? US then FNA
- If you have a 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. Female Gender.
4. Age of less than 30 years or more than 60 years.
5. Previous diagnosis of type 2 Multiple Endocrine Neoplasia (MEN-2)

❖ US Feature of Thyroid Nodules: imp

- Certain US features are helpful in differentiating between the two.
- Malignant features are:
    1. Micro-calcifications.
    2. Local invasion.
    3. A nodule that is taller than it is wider.
    4. Markedly reduced echogenicity (hypoechogenicity).
    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.

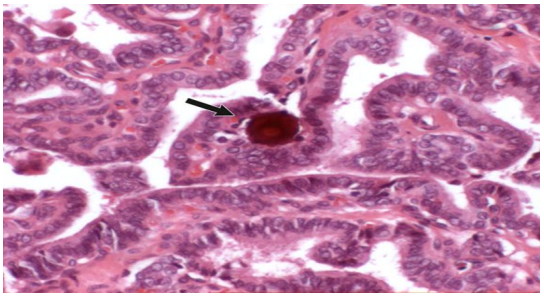
from the schedule below:

most important malignant features is mirocacification, increased internal vascularity, taller than wider and hypoechogenicity.

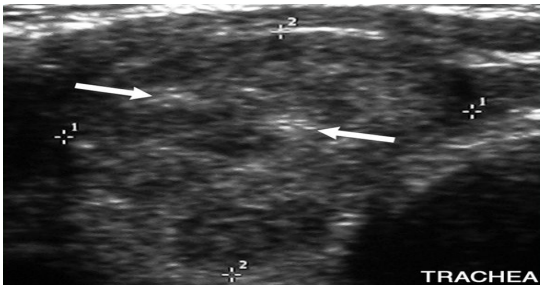
US Features Associated with Thyroid Cancer

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
Hypoechogenicity (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 y/o man:



Thyroid microcalcifications:
Photomicrograph: psammoma bodies(arrow),a round laminar crystalline calcification, which are 10–100 µm in diameter.



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

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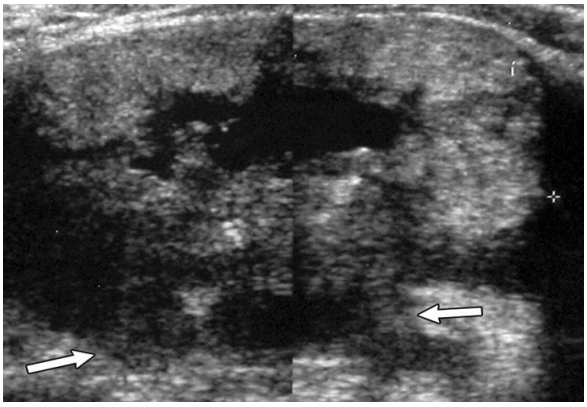
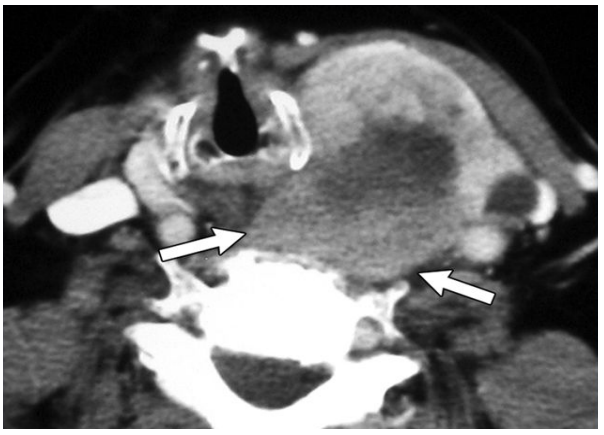
Anaplastic thyroid carcinoma in an 84-year-old woman:



Transverse sonogram of the left lobe for the thyroid shows an advanced tumor with infiltrative posterior margins (arrows) and invasion of prevertebral muscle. Anaplastic type invading the capsule and prevertebral muscles.



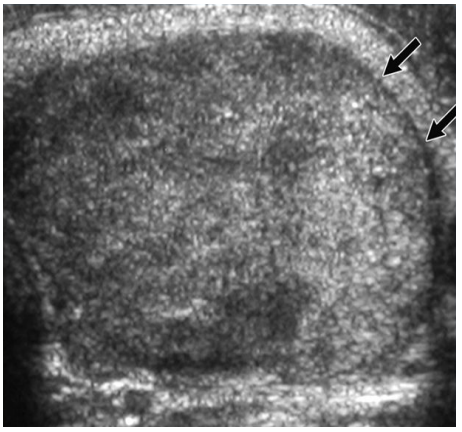
Axial contrast-enhanced CT image:
shows a large tumor that has invaded the prevertebral muscle (arrows).
Capsule invasion to prevertebral muscle & absence of halo.

❖ Margin, Contour, and Shape:

- A completely uniform halo around a nodule is highly suggestive of benignity, with a specificity of 95%. presence of halo = most likely benign.

(Pic) Follicular adenoma in a 30-year-old woman:

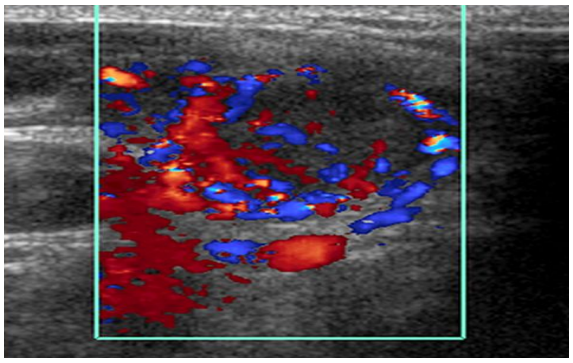
- Presence of halo/hypoechoic (the arrow) which suggests benign tumor.



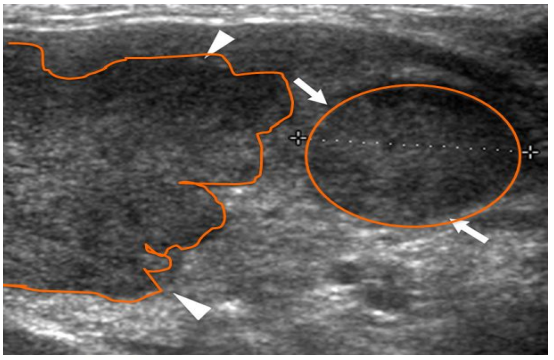
❖ Vascularity:

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

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



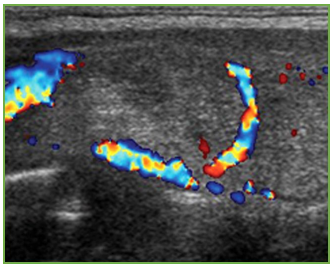
Color Doppler sonogram of the round nodule shows increased internal vascularity.



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. (Flow around the follicle, not intrinsic)



❖ Hypoechoic Solid Nodule:

- Marked hypoechogenicity is very suggestive of malignancy
- Benign ⟶ Hyper-echoic: Presence of halo ⟶ Avascularity.
- Malignant ⟶ Hypo-echogenicity: Absence of halo ⟶ Increase vascularity.

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

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

❖ 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.

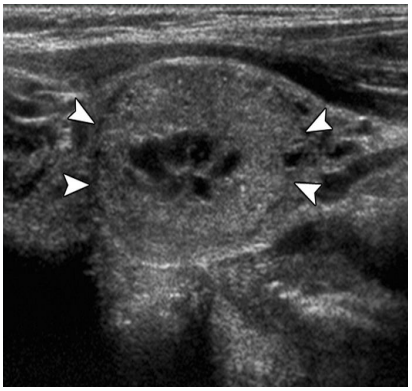
- Number of Nodules: Although most patients with nodular hyperplasia have multiple thyroid nodules and some patients with thyroid carcinoma have solitary nodules, the presence of multiple nodules should never be dismissed as a sign of benignity.

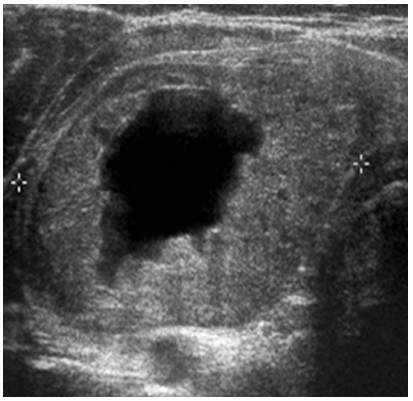
❖ Recommendations for Thyroid Nodules 1 cm or Larger in Maximum Diameter

US Feature	Recommendation
Solitary nodule	
Microcalcifications	Strongly consider US-guided FNA if ≥1 cm
Solid (or almost entirely solid) or coarse calcifications	Strongly consider US-guided FNA if ≥1.5 cm
Mixed solid and cystic or almost entirely cystic with solid mural component	Consider US-guided FNA if ≥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*

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

Left



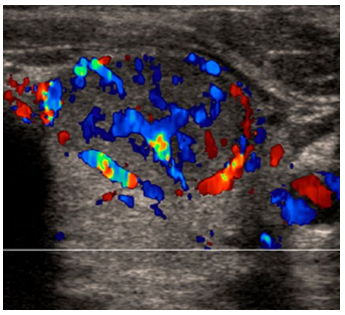


Right

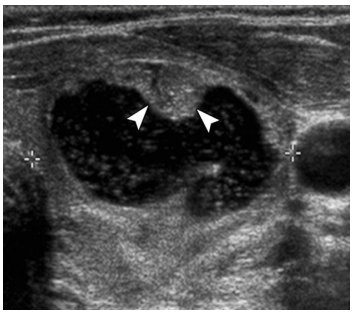
- Left image: Sagittal image of predominantly solid nodule (arrowheads), which proved to be benign at cytologic examination.
- Right image: Transverse image of mixed solid and cystic nodule (calipers), which proved to be benign at cytologic examination.
- **both images have halo = benign tumor**

❖ Vascularity suggests malignancy:

- Predominantly solid thyroid nodule: Addition of color Doppler mode shows marked internal vascularity, indicating increased likelihood that nodule is malignant. This was a papillary carcinoma.



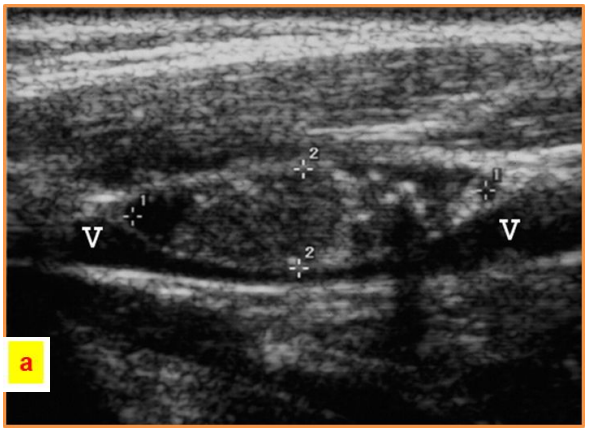
- Gray-scale image shows predominantly cystic nodule (calipers) with small solid-appearing mural component (arrowheads). **+ Halo**
- in addition of color Doppler mode demonstrates flow within mural component (arrowheads), confirming that it is tissue and not debris. US-guided FNA can be directed into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



❖ US Features of Malignant Lymph Nodes

1. Rounded bulging shape. 2. Increased size. 3. Replaced fatty hilum . 4. Irregular margins.
5. Heterogeneous echotexture. 6. Calcifications. 7. Cystic areas.
8. Vascularity throughout the lymph node instead of normal central hilar vessels at Doppler imaging.

❖ Abnormal cervical lymph nodes.

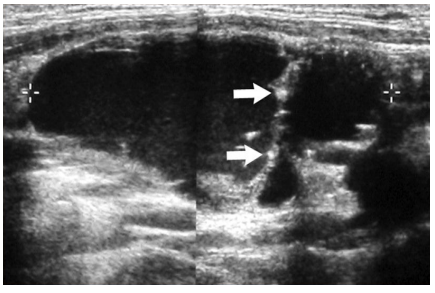


(a) Sagittal US image of enlarged node (calipers) with central punctate echogenicities, consistent with microcalcifications, shows mass effect on internal jugular vein (V) (compression). it was proved to be metastatic papillary carcinoma.

(b) Sagittal US image of enlarged node (calipers) with cystic component. It was proved to be metastatic papillary carcinoma.

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

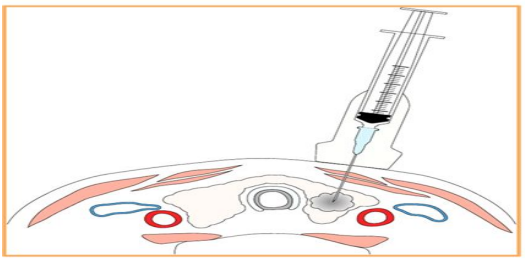
- US shows irregular hypoechoic tumor and microcalcification, the arrows refer to foci microcalcification.
- If there is cysts → another indication for malignant.

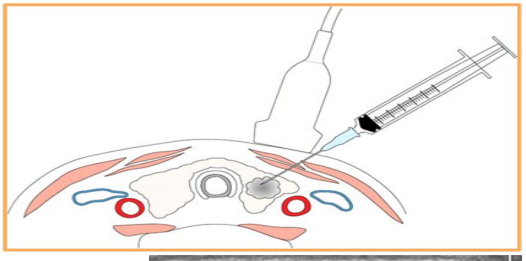


❖ US-guided FNA Technique:

- The needle may be introduced parallel or perpendicular to the transducer, and the needle tip should be carefully monitored during the procedure. Diagram shows insertion of the needle in a plane parallel to that of scanning

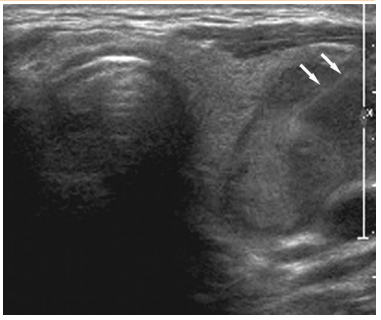
medial to thyroid lobe is trachea, lateral is carotid artery (so try to avoid harming these structures during FNA)





Parallel positioning of the fine-gauge needle for thyroid nodule biopsy.

- US image, obtained with the transducer and needle positioned as in a, depicts the entire length of the needle (arrows) within the nodule.
- This positioning helps maximize the number of needle-generated reflected echoes perpendicular to the sound wave and is preferred by many operators



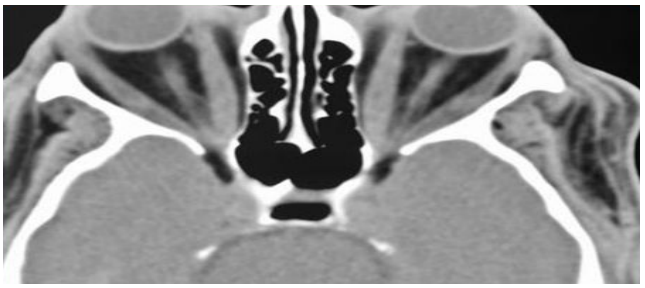
Thyroid Ophthalmopathy (Graves' Disease)

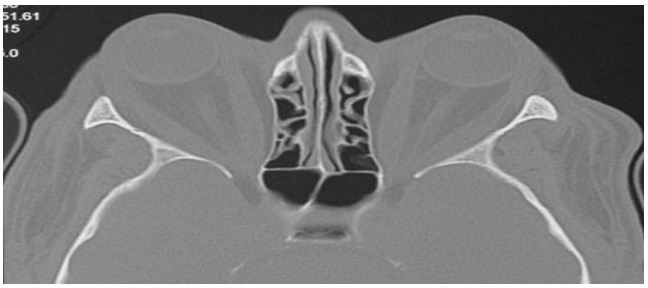
❖ Clinical history:

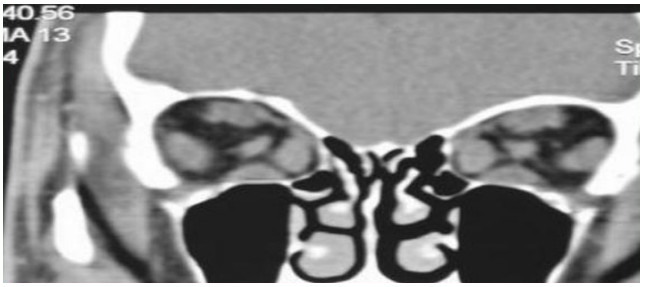
- Slow onset (months), painless exophthalmos.

❖ Patterns of muscle involvement in thyroid ophthalmopathy:

1. Bilateral (85%)
2. Unilateral (5%)
3. Normal muscles (10%)
   - Involvement of All muscles is the most common scenario of extraocular muscle enlargement.
   - If only individual muscles involved, commonly its Inferior than 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. (does not affect the tendon)
   - Patients should not be having hyperthyroid (some have euthyroid).
   - **Coronal imaging** is the method of choice for assessing muscle thickness





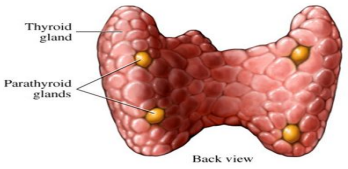


❖ Radiological features: The disease is bilateral 1. Exophthalmos protrusion. 2. Enlargement of extraocular muscles. 3. increased retrobulbar fat pad. 4. herniation in the fat through superior ophthalmic fissure. 5. medial impression of lamina propecia. 6.Stretching of optic nerve.

Parathyroid Gland

❖ Anatomy of PT gland:

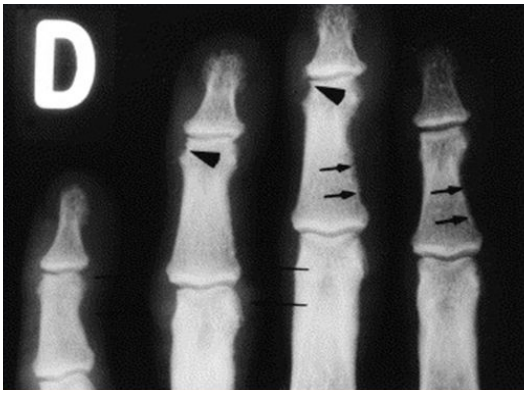
- Two pairs of glands usually positioned behind the left and right lobes of the thyroid.
- Typically 4 parathyroid glands (Superior and Inferior) parathyroid glands.



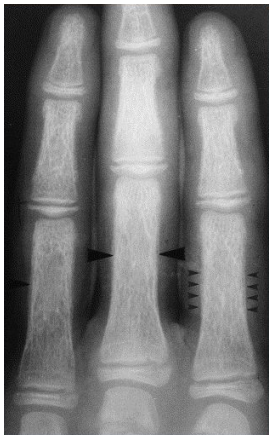
❖ Renal Osteodystrophy

- Seen in setting of: chronic, end-stage renal disease.
- Related to combination of:
    1. Osteomalacia.
    2. Secondary hyperparathyroidism
- Features: (MCQ)
    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 the most common finding; however, 10-20% of patients also exhibit osteosclerosis.
- Characteristic finding of osteosclerosis is "Rugger jersey spine MCQ" , Bands of hazy sclerosis that parallels the vertebral body endplates.
- Both axial and appendicular skeleton involved.
- Increased risk for pathologic fracture

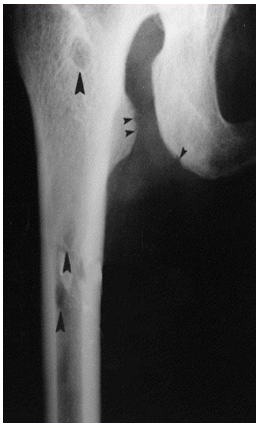


- Typical subperiosteal bone resorption at the "radial aspects of the middle phalanges (MCQ)" with bone resorption at the margins of the distal interphalangeal joints.
- Typical feature of secondary parathyroid in the sitting of renal osteodystrophy



Cortical thinning

rugger jersey spine



Subligmanetum resorption + brown tumors