Parathyroid Ultrasound

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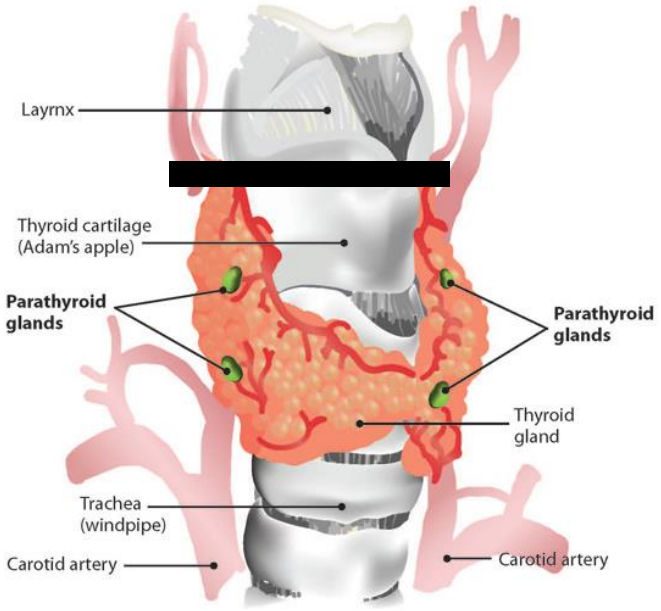
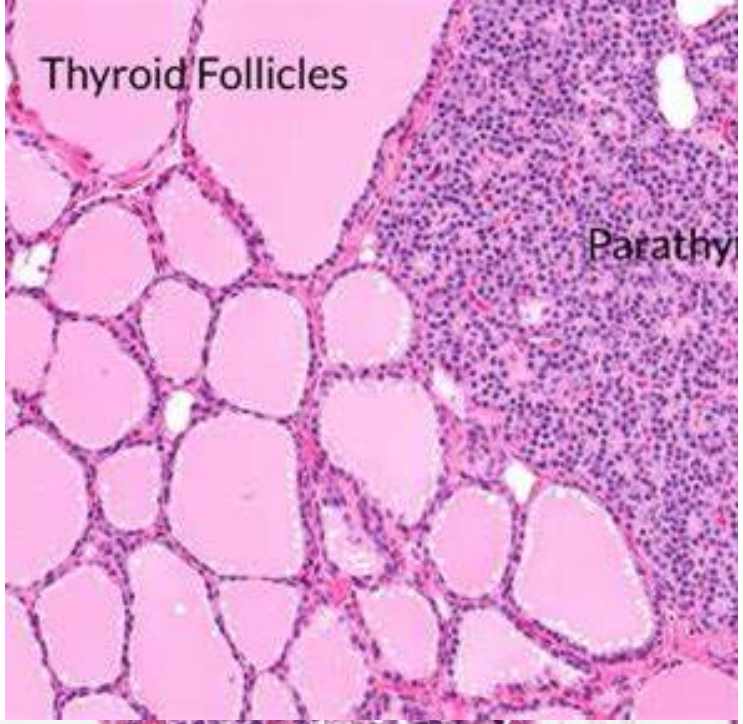
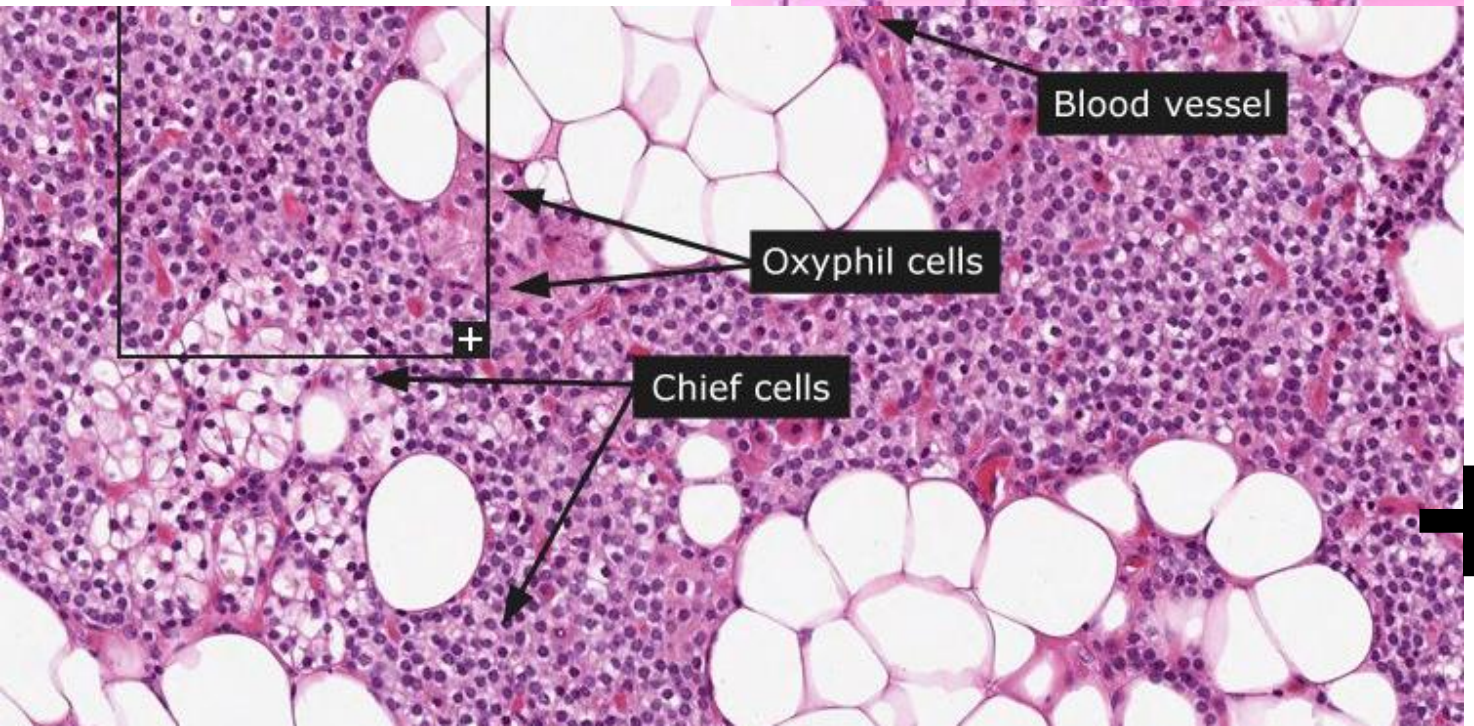
Consultant Radiographer/Sonographer & Clinical Lead for Ultrasound

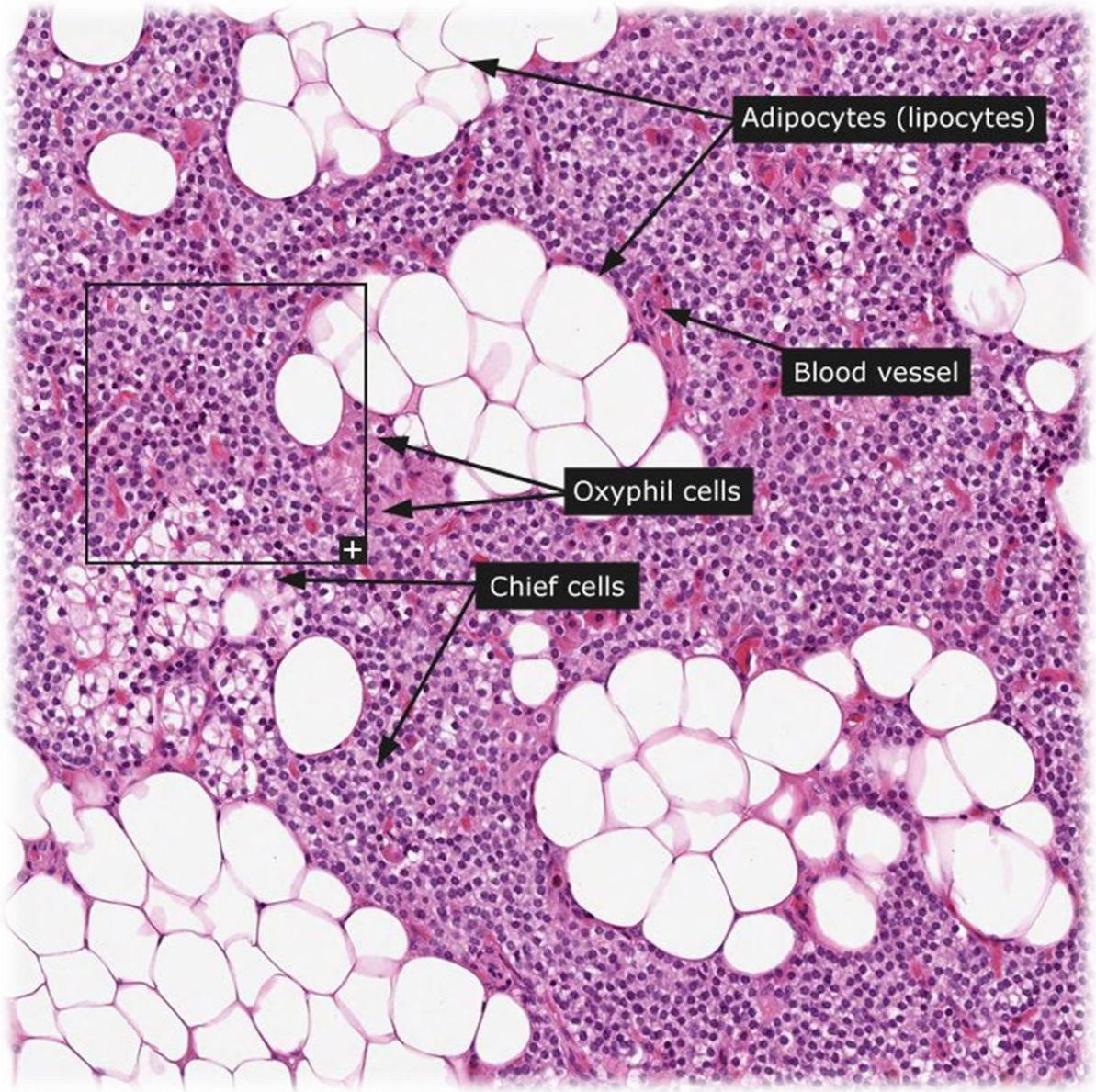


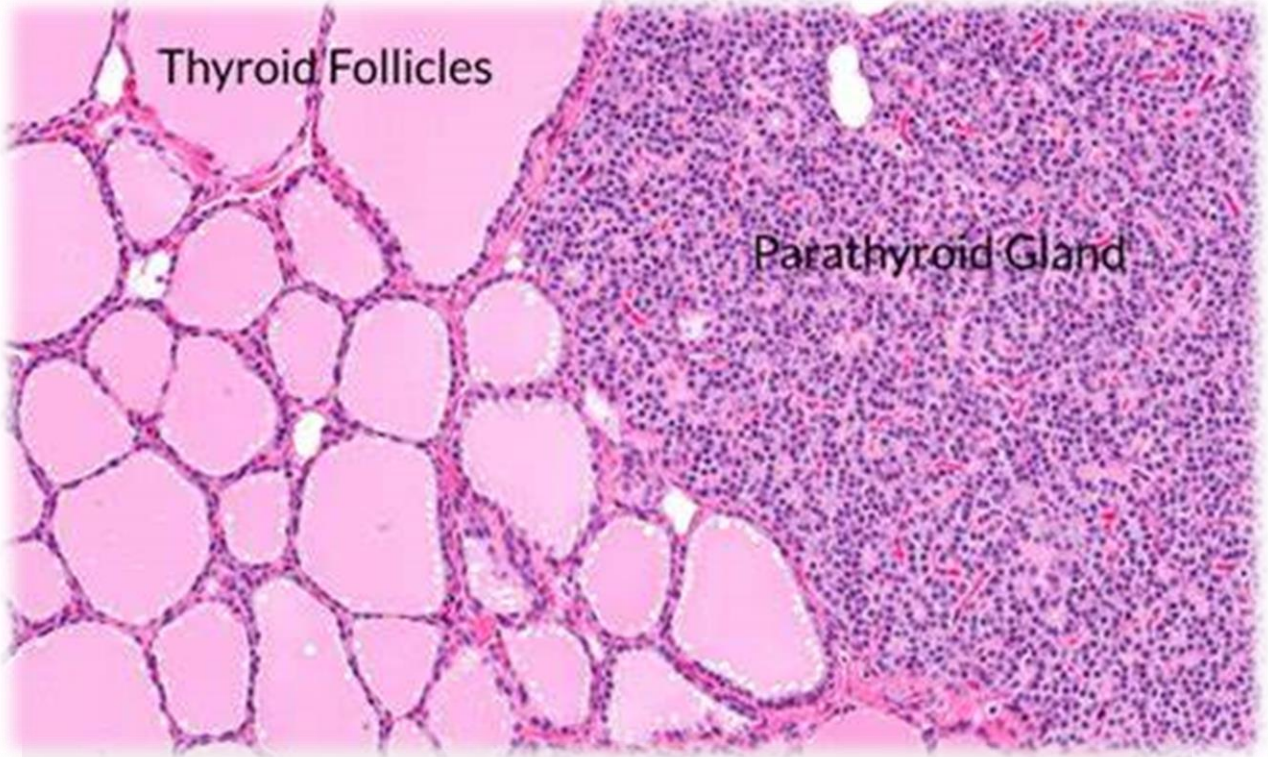




Parathyroid Glands

- There are usually 4 glands
  - 1 superior and 1 inferior to each thyroid lobe
  - Partially embedded in the posterior surface of the lateral aspects of the thyroid lobes
- Parathyroid Hormone (PTH)
  - Major regulator of ion levels in blood:
    - Calcium (Ca^{2+})
    - Magnesium (Mg^{2+})
    - Phosphate (HPO_4^{2+})

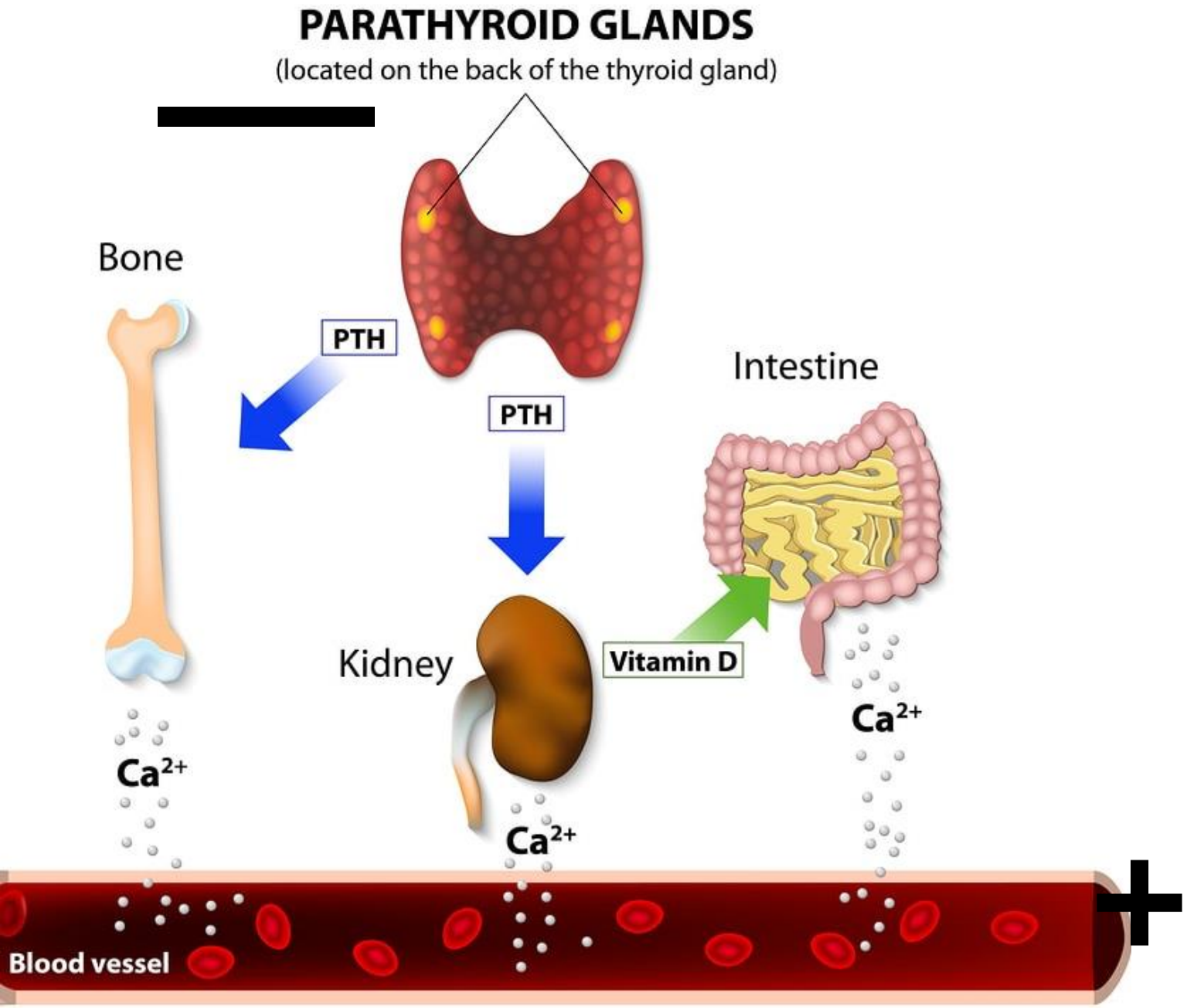




Microscopic Anatomy

Parathyroid gland contains two types of epithelial cells:

- Chief (principal) cells
  - Majority of the cells in the parathyroid
  - Produces Parathyroid Hormone (PTH)
- Oxyphil cell
  - Function not known
  - Begin in puberty and increase with age



Parathyroid Hormone Secretion

- Calcitonin secreted by high blood Ca^{2+} levels in thyroid
- Calcitonin inhibits osteoclast activity, therefore reducing Ca^{2+} levels
- Lower than normal Ca^{2+} levels stimulates chief cells to produce more PTH
- PTH promotes resorption of bone matrix, releasing more Ca^{2+} into blood and reduces Ca^{2+} levels loss via urine
- PTH also stimulates kidney production of calcitriol (active form of Vit D)
- Calcitriol stimulates increased absorption of Ca^{2+} from food via GI tract

Hyperparathyroidism

- Primary Hyperparathyroidism
  - one or more of the parathyroid glands makes too much PTH.
  - can lead to the loss of bone tissue.
- Secondary Hyperparathyroidism
  - occurs due to another disease that first causes low calcium levels in the body.
  - increased PTH levels occur as the body fights to keep the Ca level up in the standard range.
  - common in kidney disease and after certain GI surgeries or diseases.
- Tertiary Hyperparathyroidism
  - usually happens after long-term secondary hyperparathyroidism when the parathyroid glands have been producing high levels of PTH for such a long time that they become overgrown and permanently overactive.
  - leads to high blood calcium levels.

85%- single gland disease

Signs of Hyperparathyroidism

- Depression
- Tiredness
- Feeling thirsty and peeing a lot
- Feeling sick and losing your appetite
- Muscle weakness
- Constipation
- Abdominal pain
- Loss of concentration
- Mild confusion

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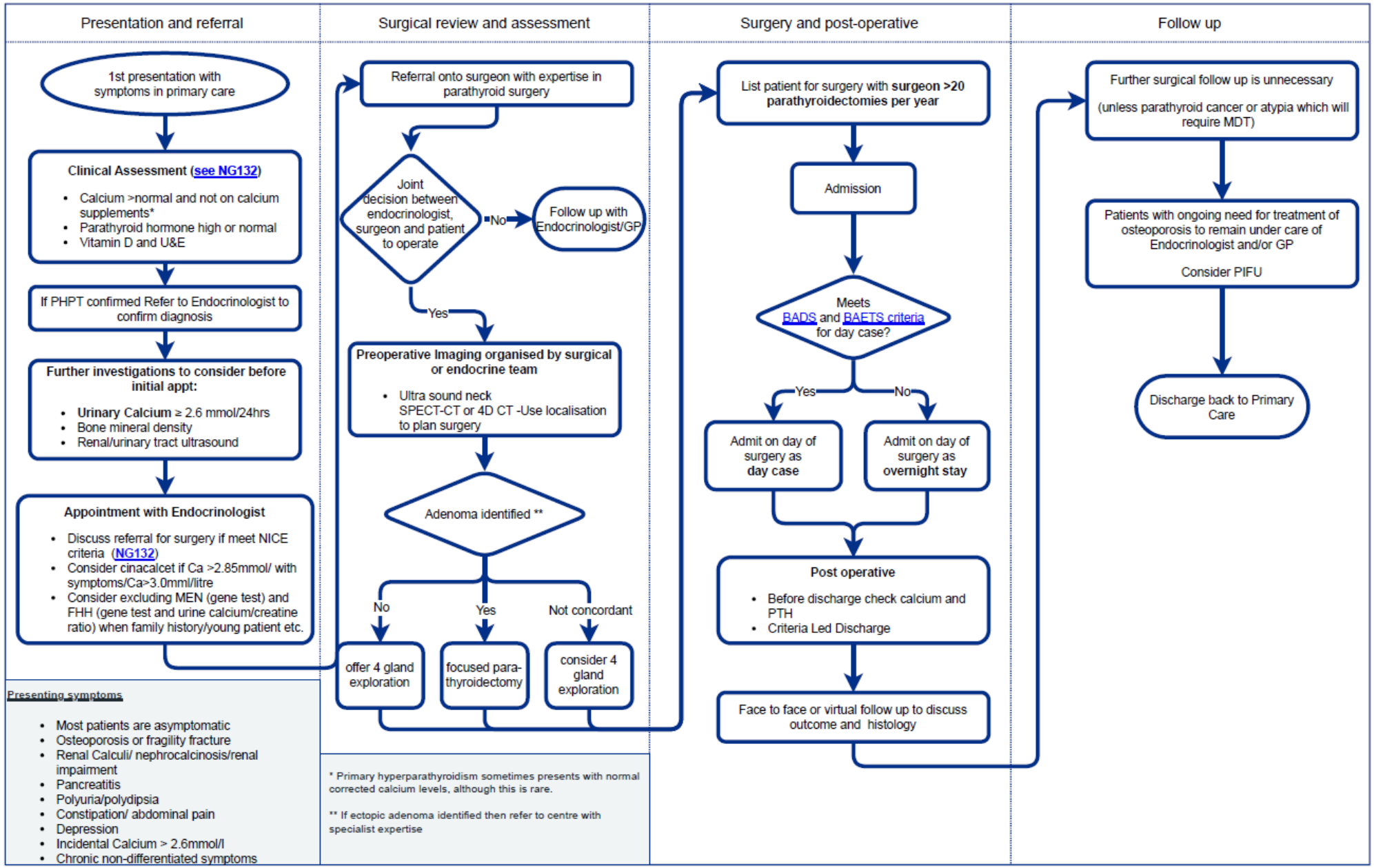
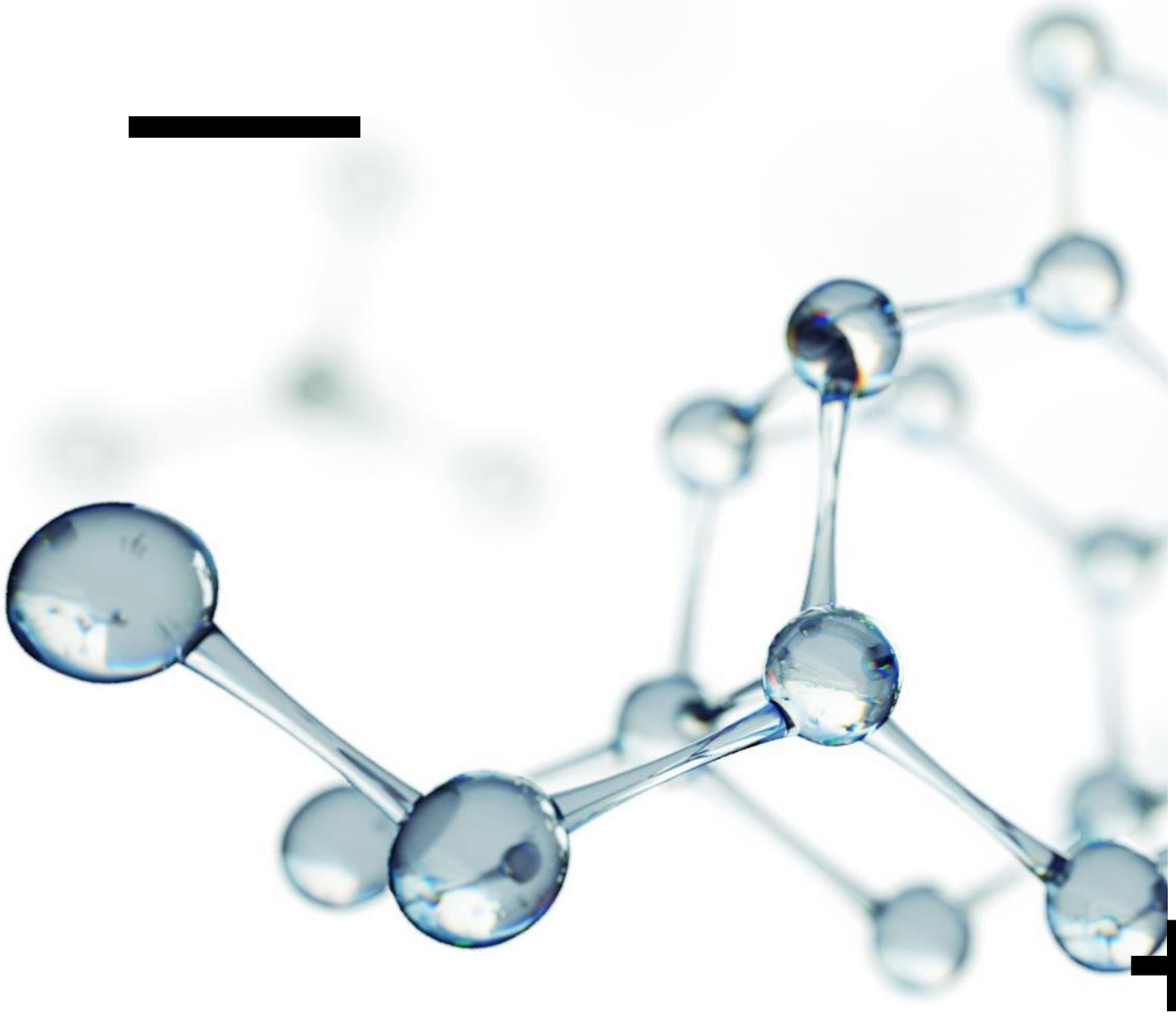
Primary Hyperparathyroidism

Endocrinology





Radionuclide Imaging

– Technetium 99m Sesta MIBI

– PET Choline CT

– Gallium68 DOTATOC PETCT

SPECT /CT

Siemens Intevo

Philips Brightview XCT

GE Discovery NM/CT 670

PET / CT

Siemens mCT Flow

Philips Vereos

United Imaging uMI 780

GE Discovery IQ

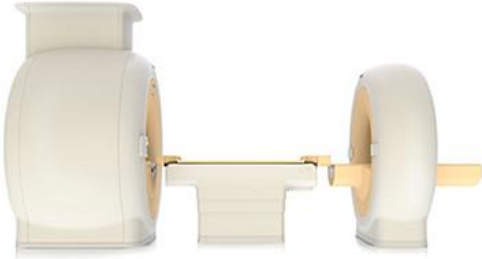
Toshiba Celesteion

PET / SPECT /CT

Mediso Anyscan

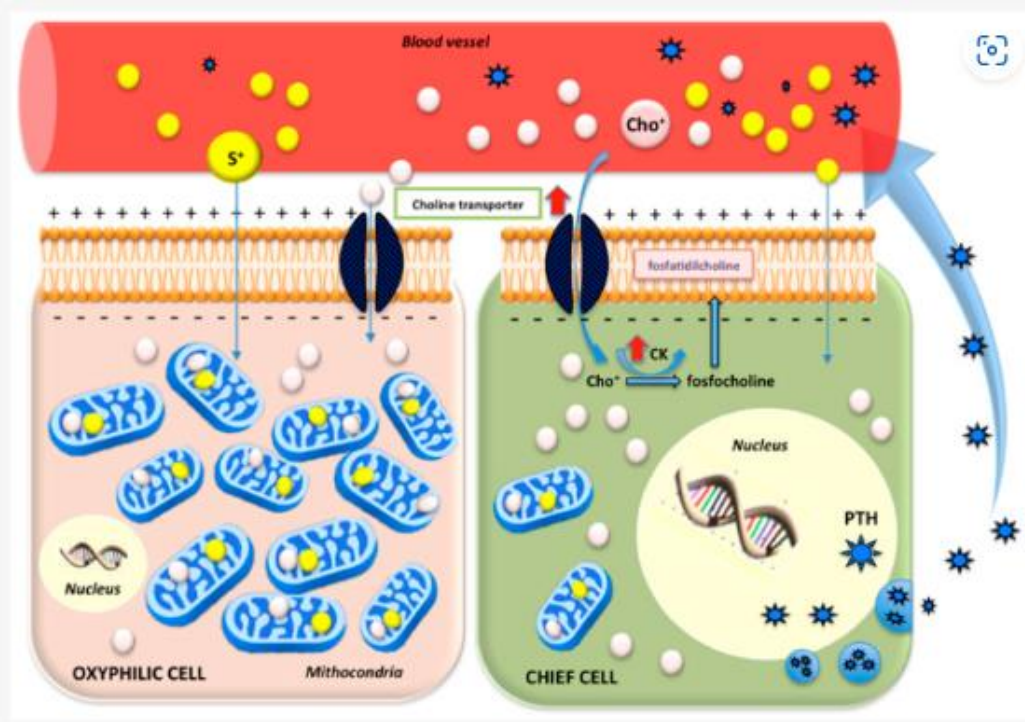
PET / MR

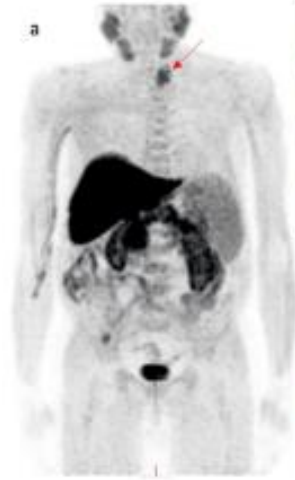
Siemens mMR

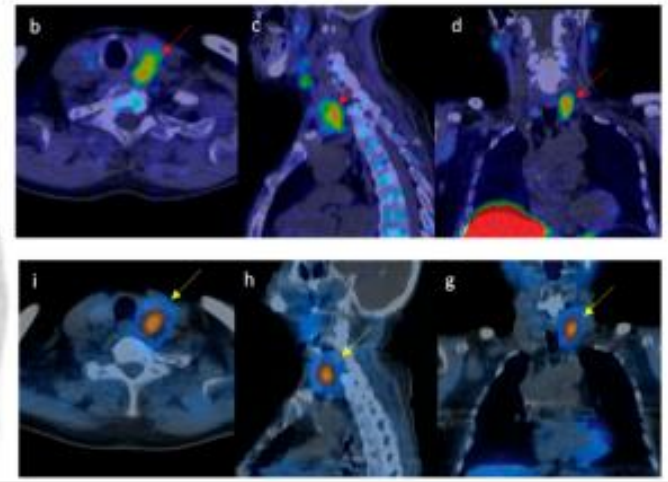


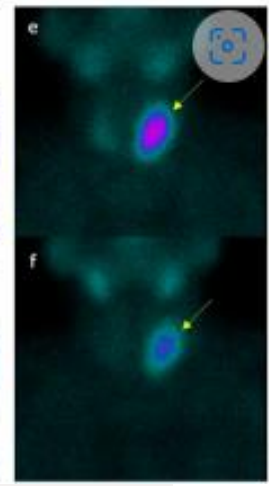
Philips Ingenuity

GE Signa







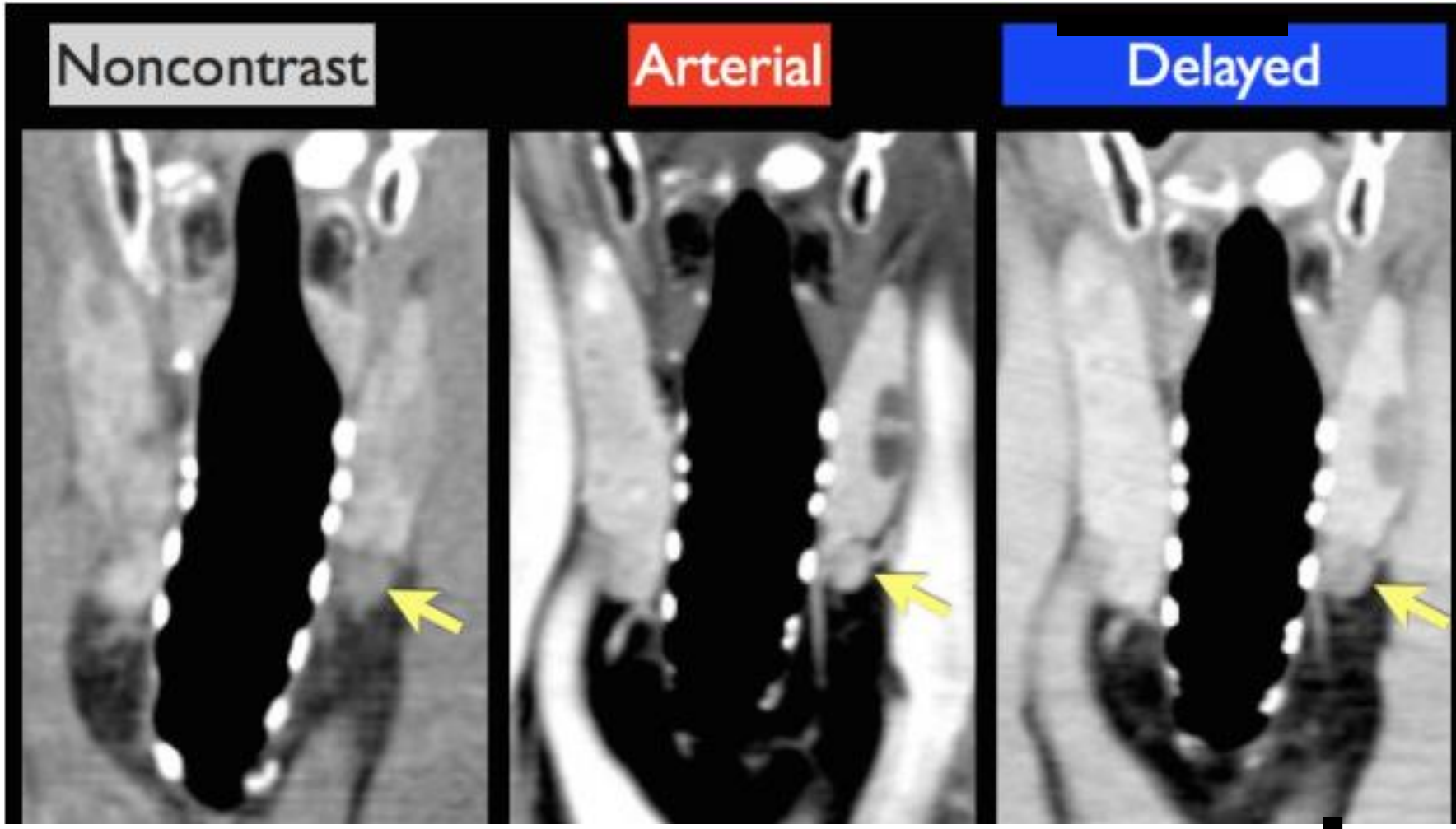


Tc99m-SestaMIBI

- Two-phases (15mins and 120 mins)
- Can sometimes demonstrate thyroid adenomata
- SPECT
- Most common test (after US)

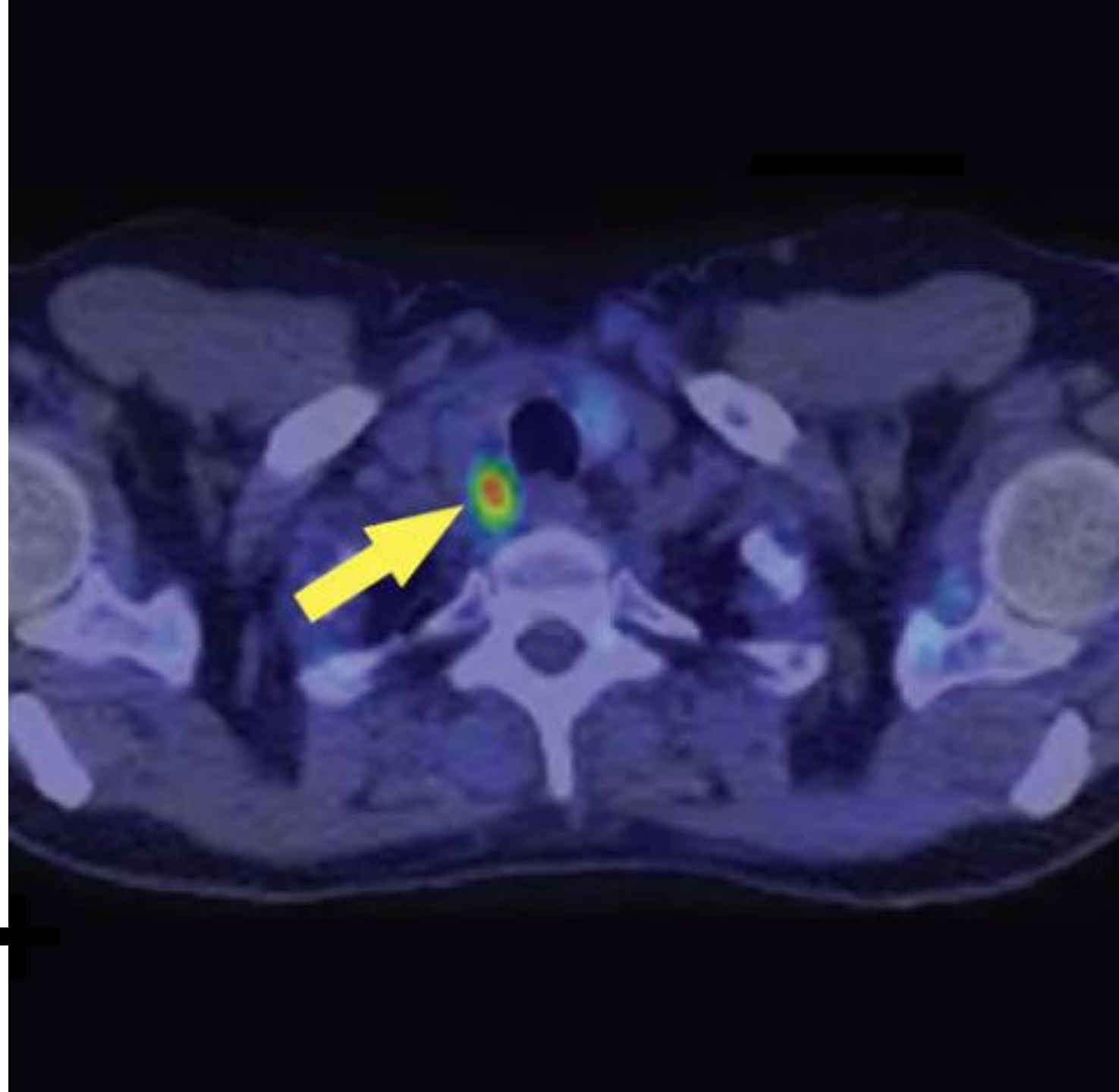
Computed Tomography

- 4D CT (Multiphase study)
- Useful when US and MIBI negative studies
- Parathyroids (like NETs) are hypervascular
- Useful for ectopic lesions



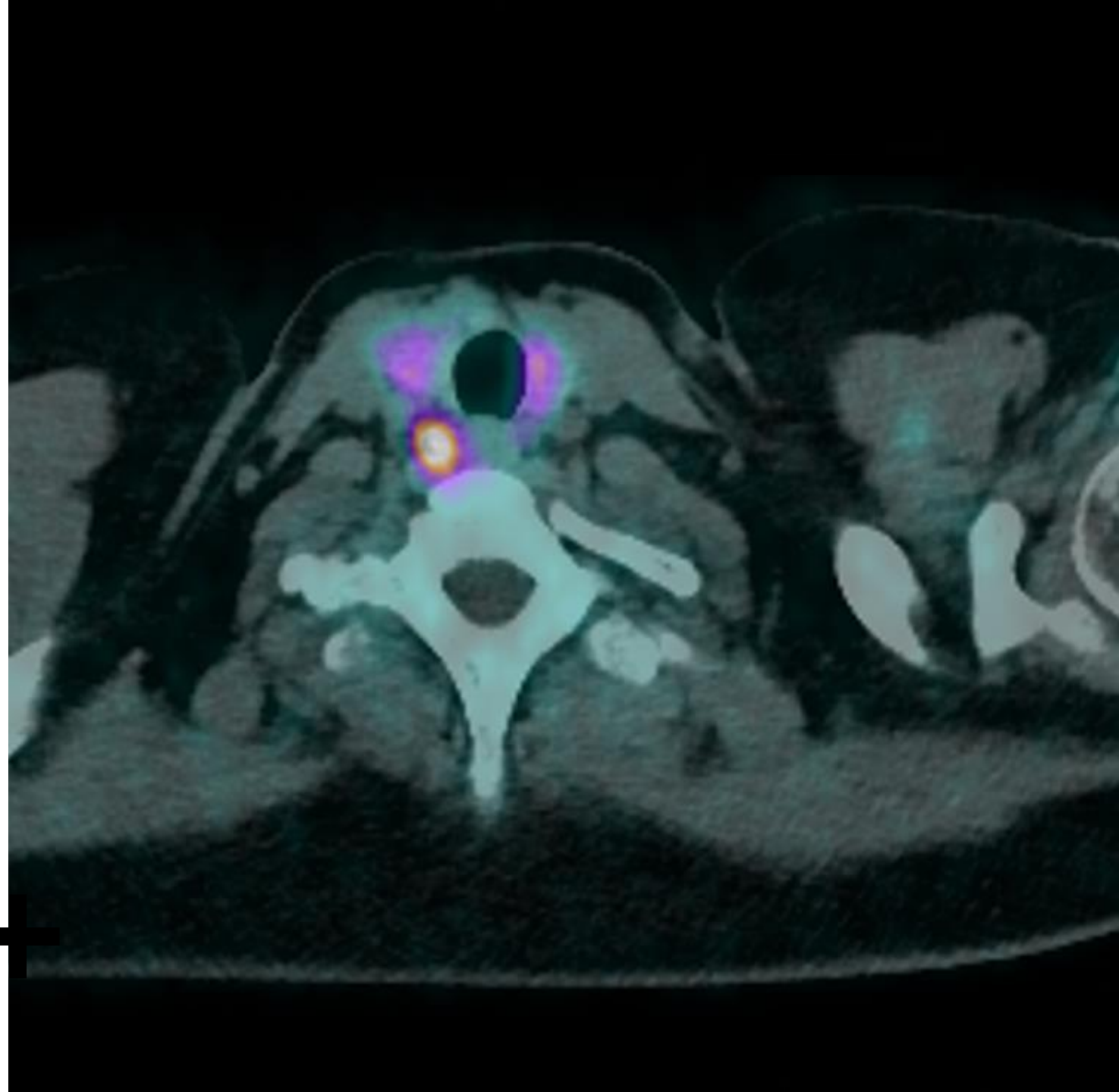
PET Choline CT

- Increased cell metabolism in adenoma or hyperplasia leads to increased choline uptake .
- Upregulation of choline kinase activity leads to enhanced choline uptake.
- Hybrid imaging offers the possibility of attenuation correction and co-registration of functional and anatomical information.
- Advantage of PETCT over SPECT is its superior spatial resolution.



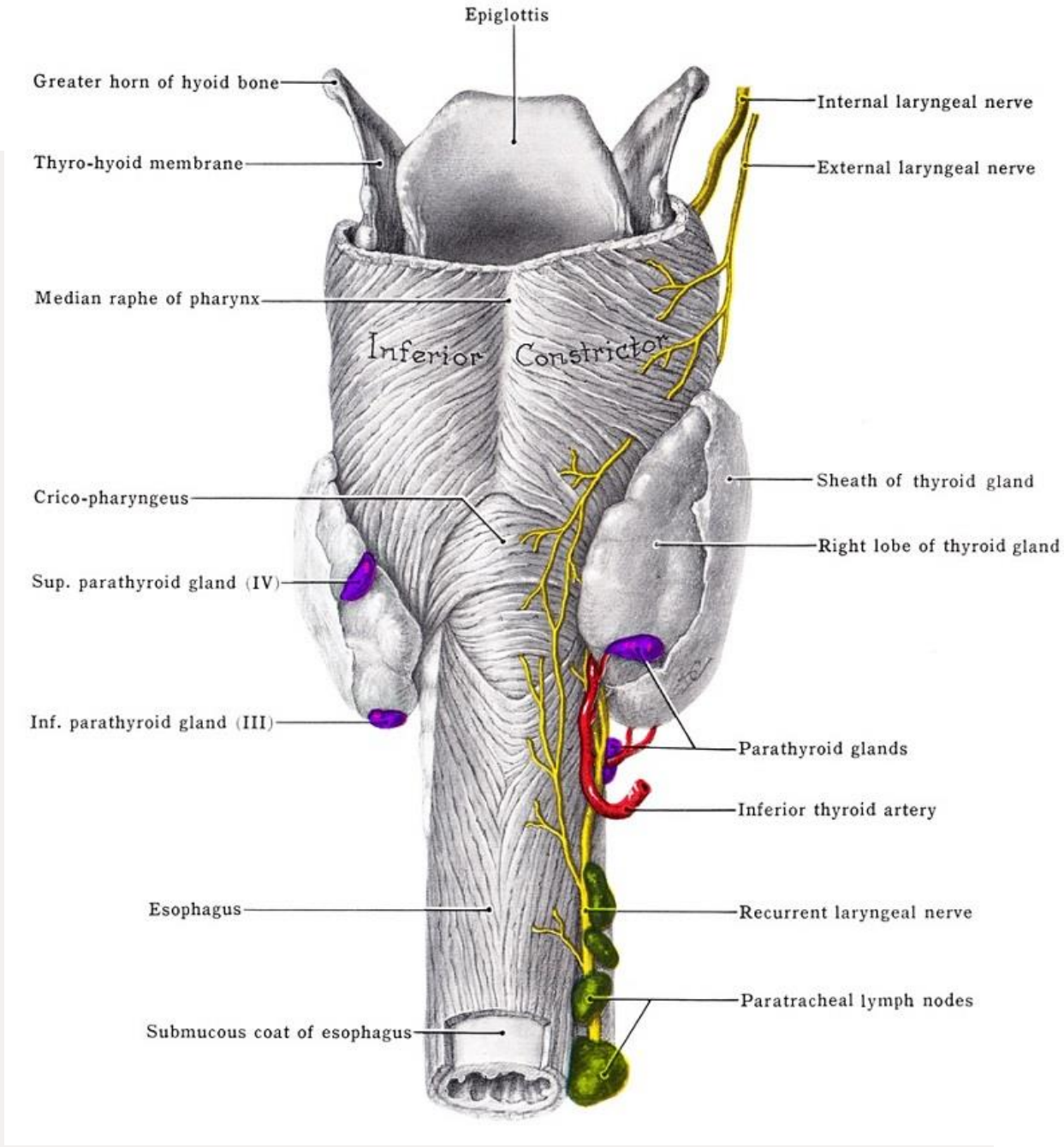
Ga68-Dotatate

- Gallium 68 PET radiotracer
- Somatostatin receptor
- NETs
- Not financed on national contracts

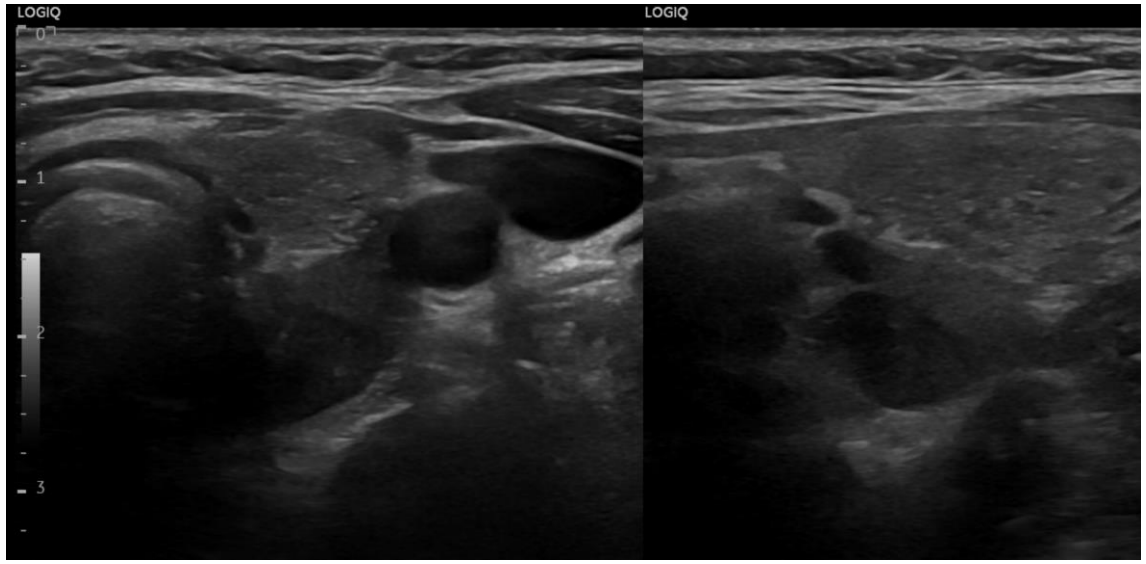


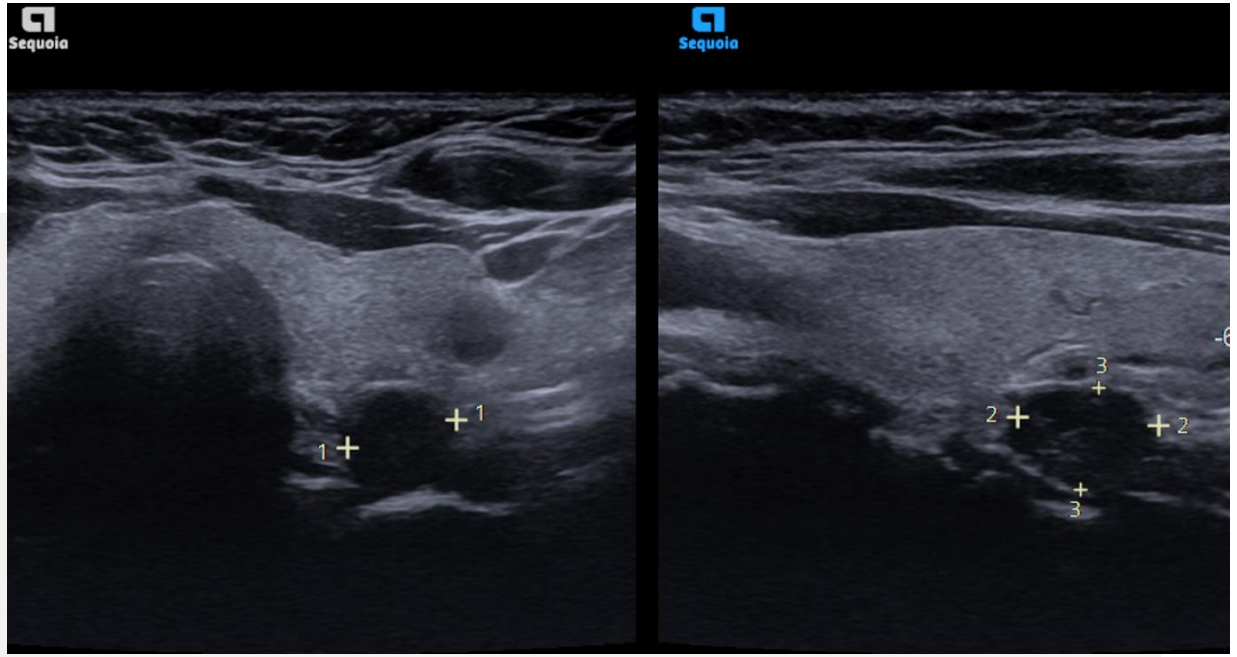
Parathyroid Imaging

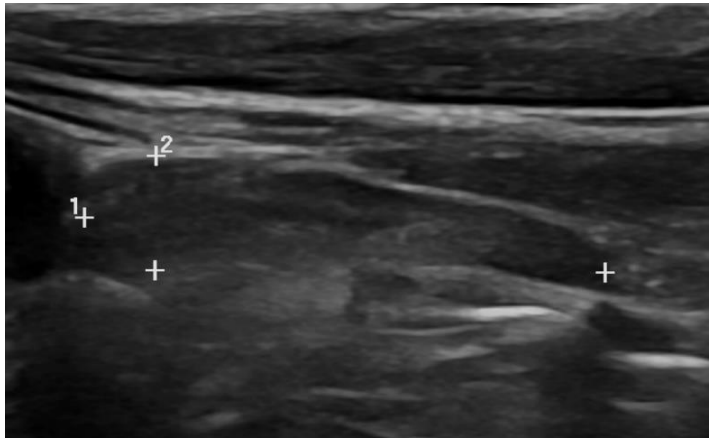
- Main clinical indication for Parathyroid US is for pre-surgical localisation only.
- Best Practice Suggestions:
  - Sestamibi first prior to US!
  - Only take referrals from endocrine surgeons
  - Parathyroids are very difficult to visualise and can be ectopic (in thorax)
  - Parathyroid adenomata can look like normal small lymph nodes
  - FNAC or Fluid PTH analysis
  - Sestamibi does not always see them
  - Beware the thyroid adenoma vs intrathyroidal parathyroid
  - PET Choline, Ga68 DOTA & 4DCT

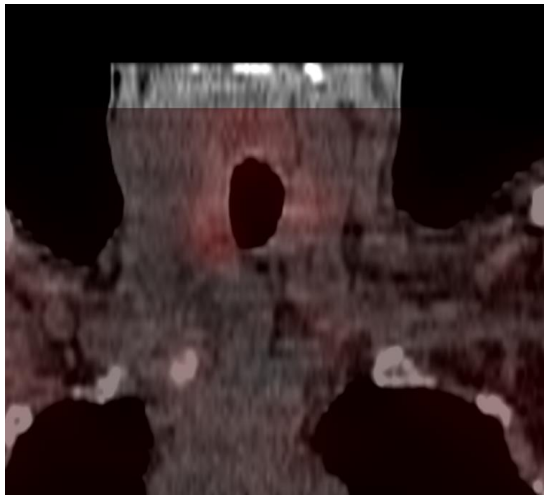


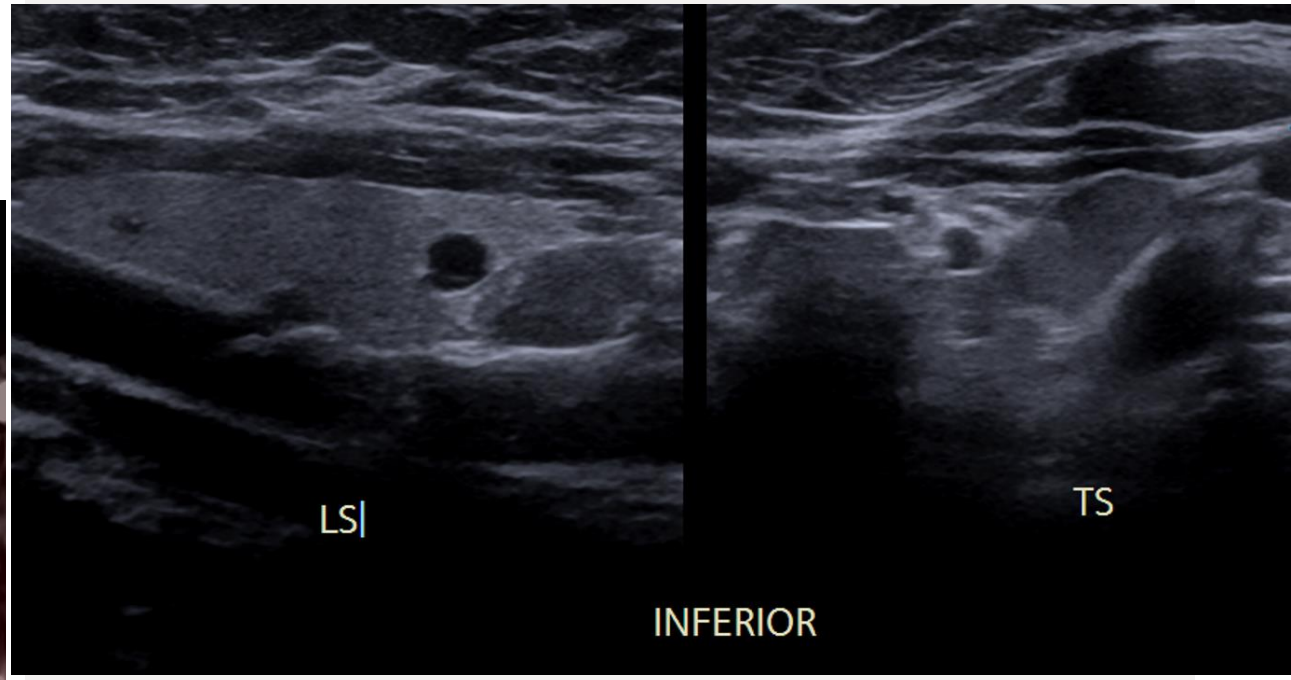
Parathyroid Glands



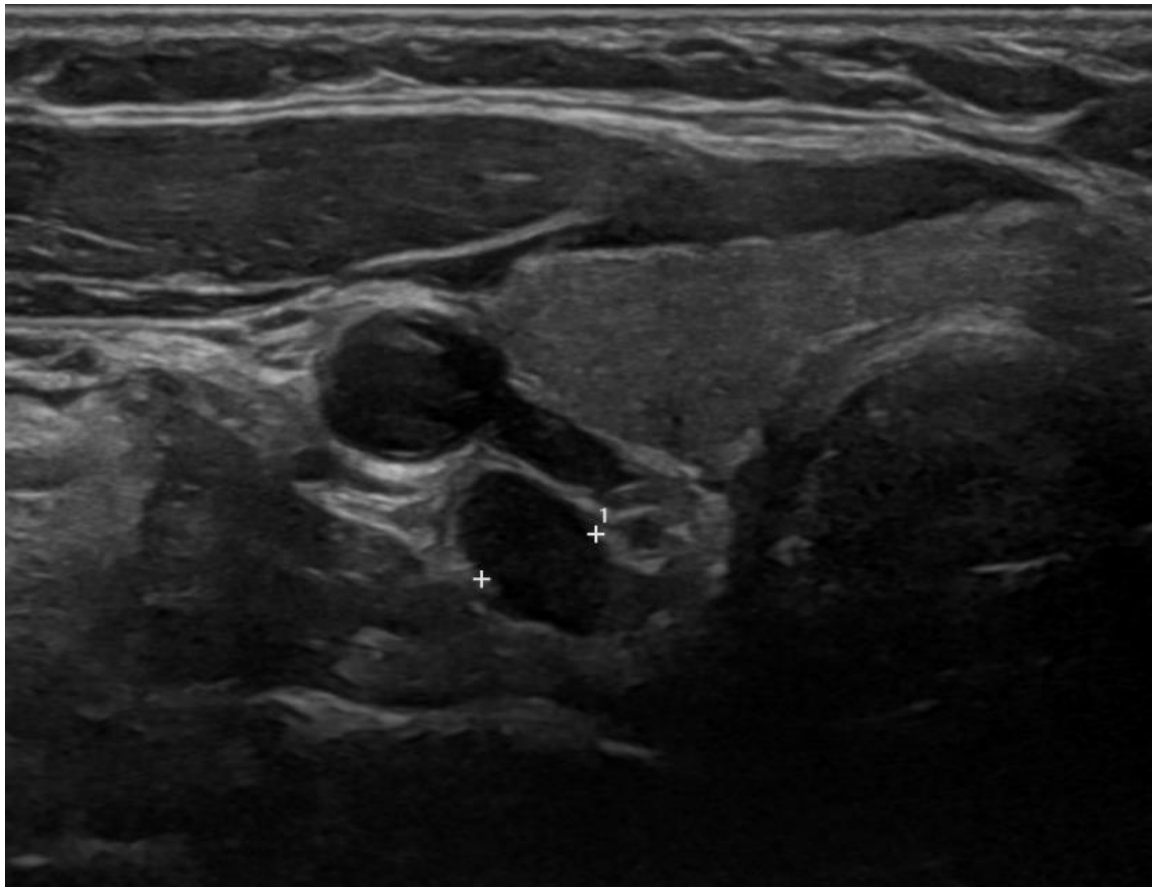


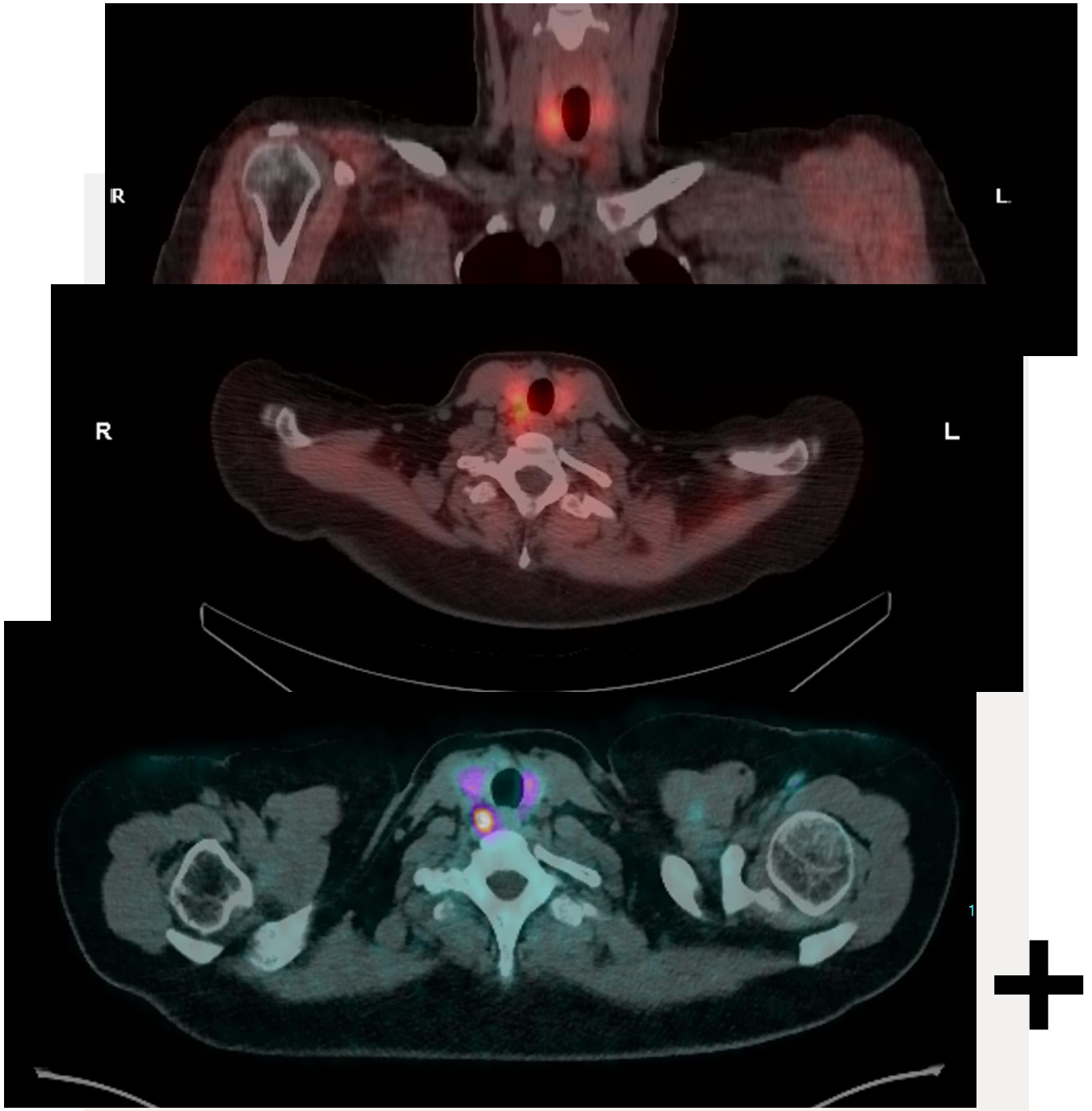




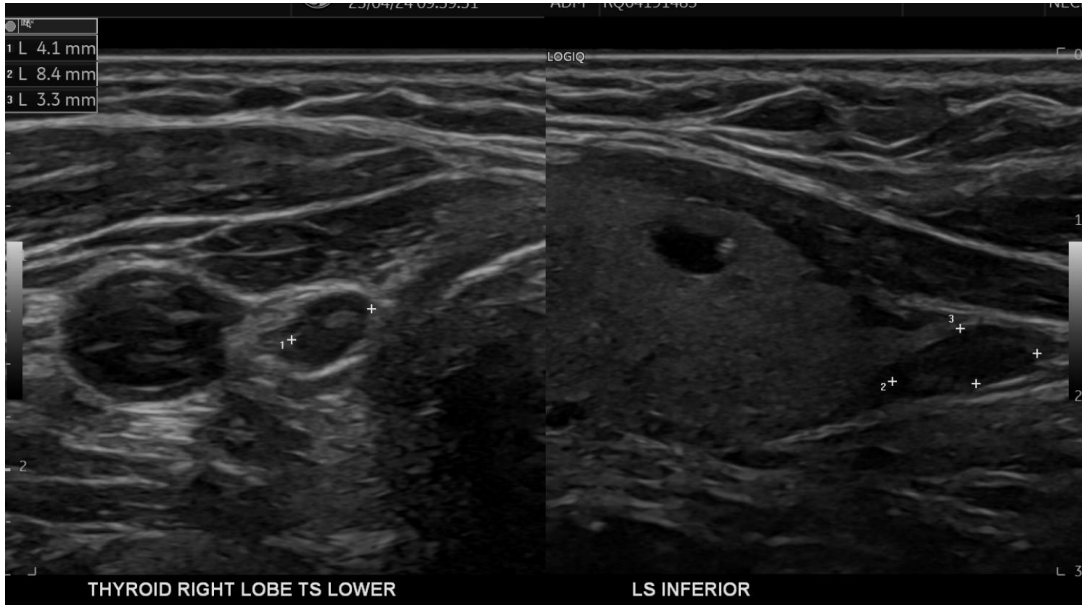


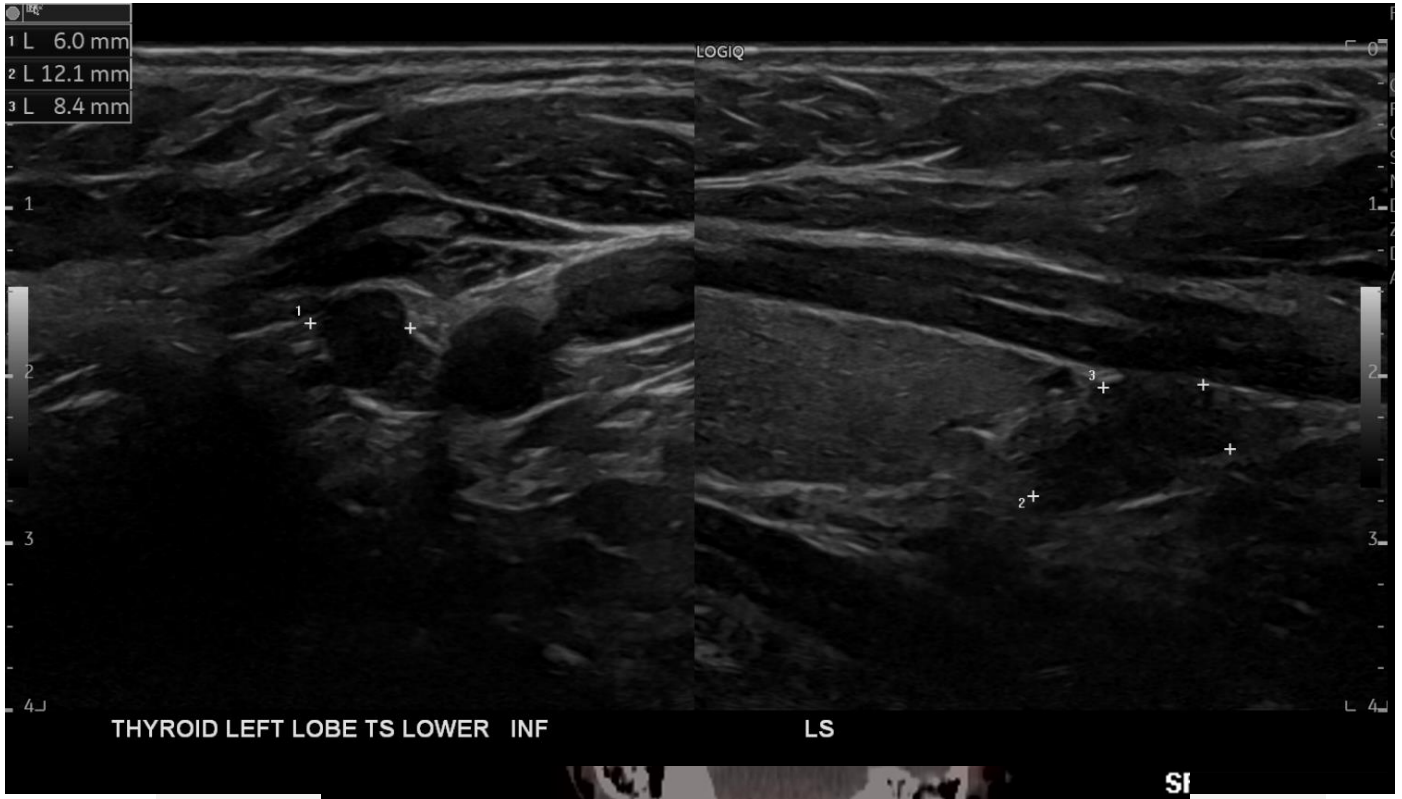
Parathyroid Glands

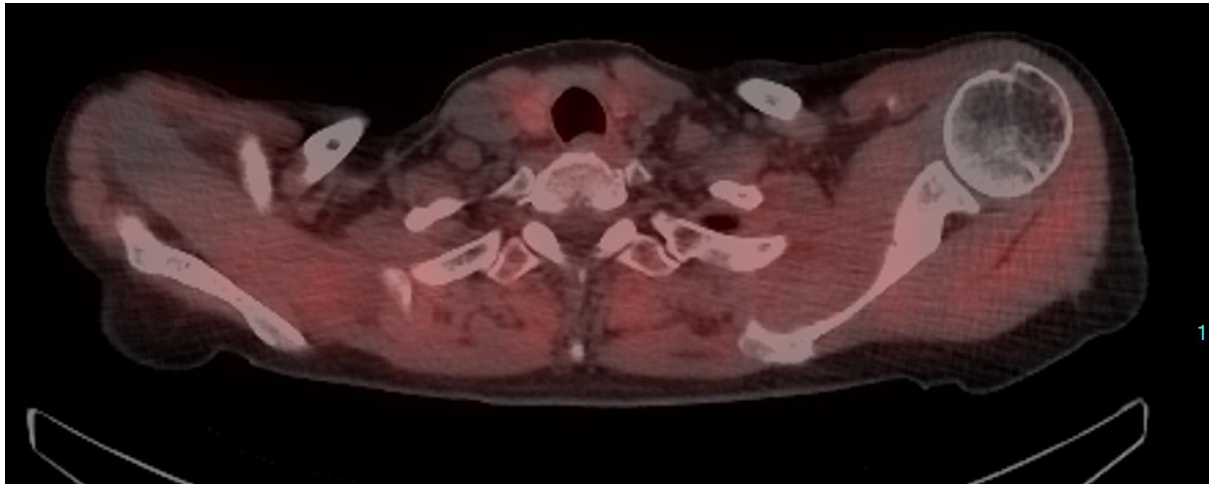




Parathyroid Glands







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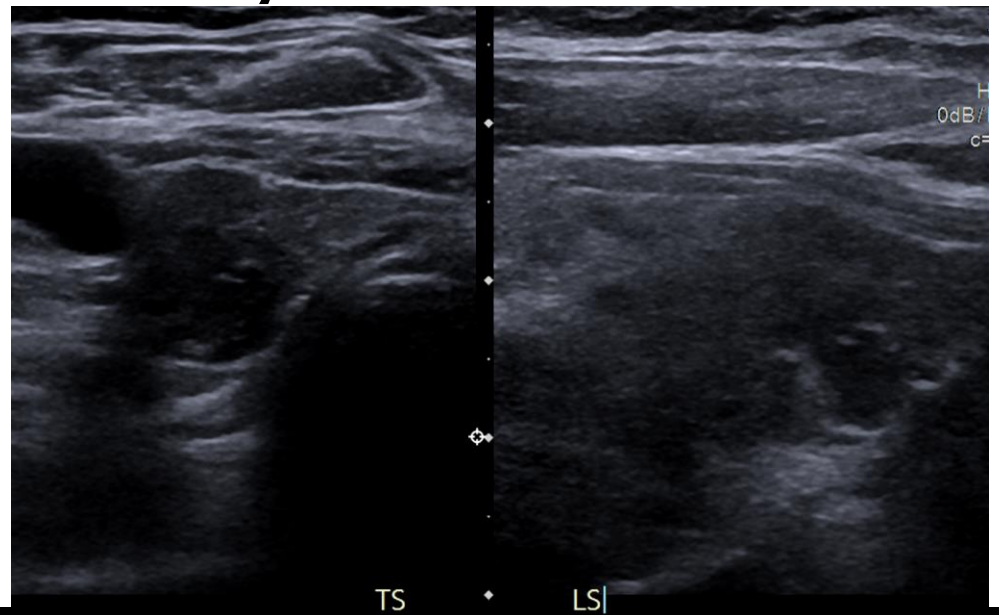
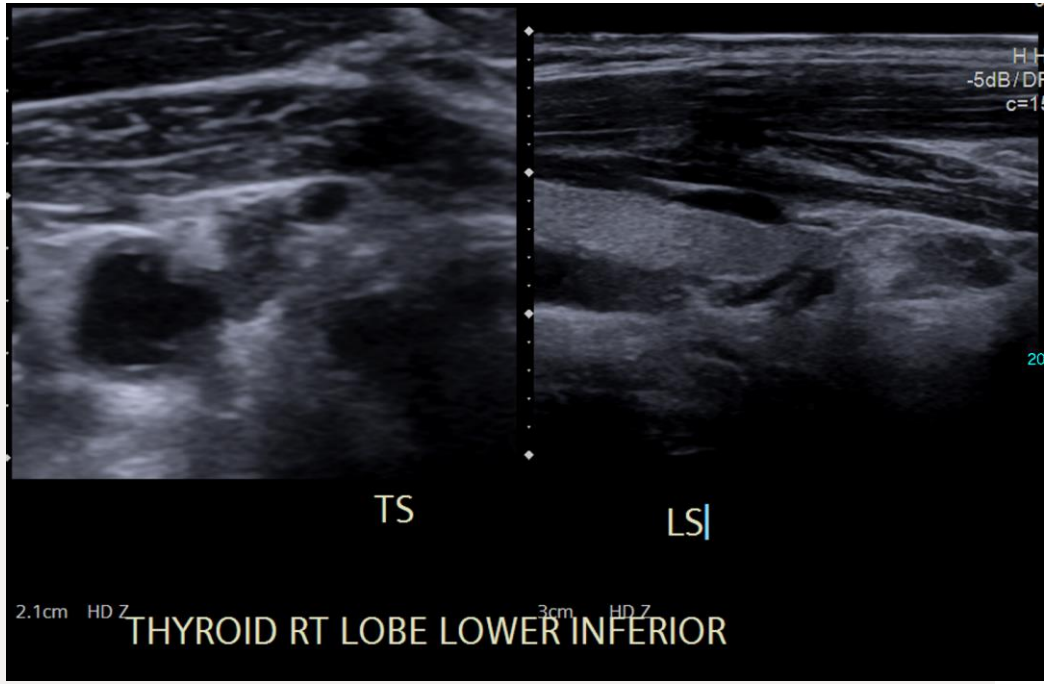
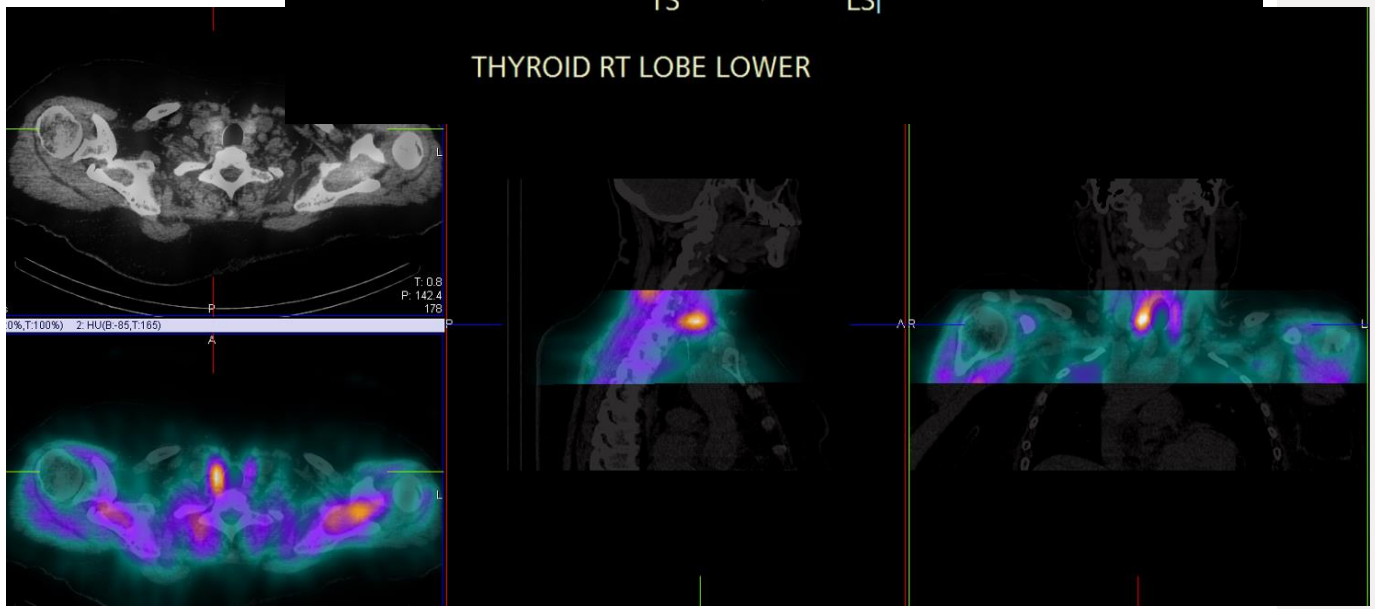
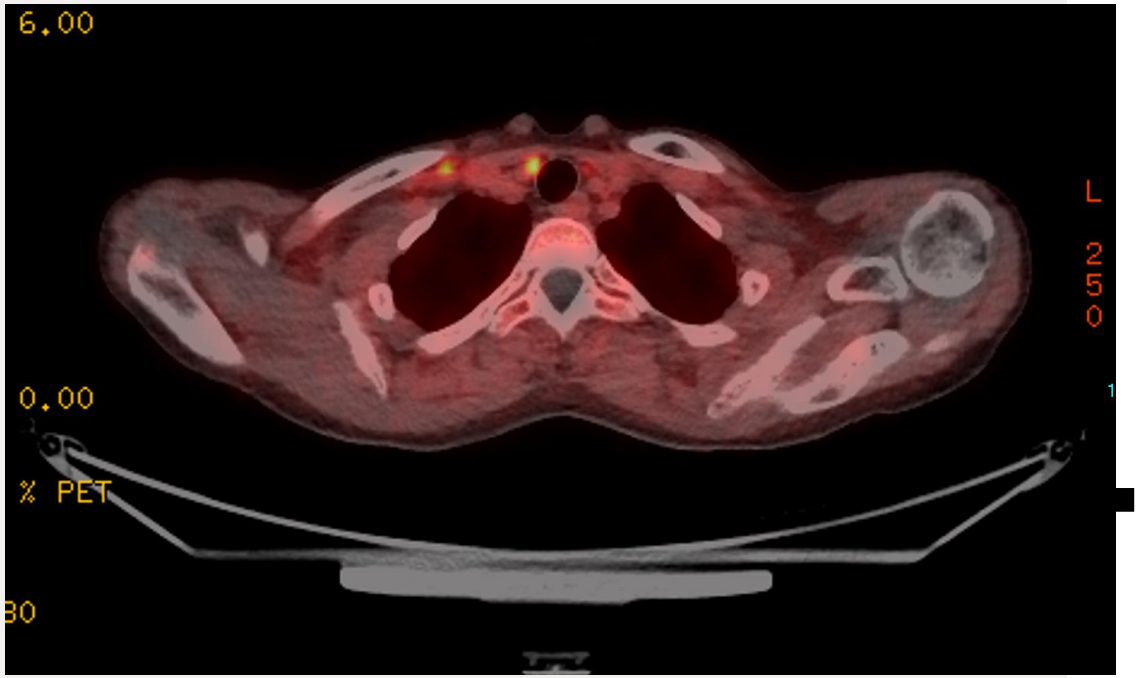
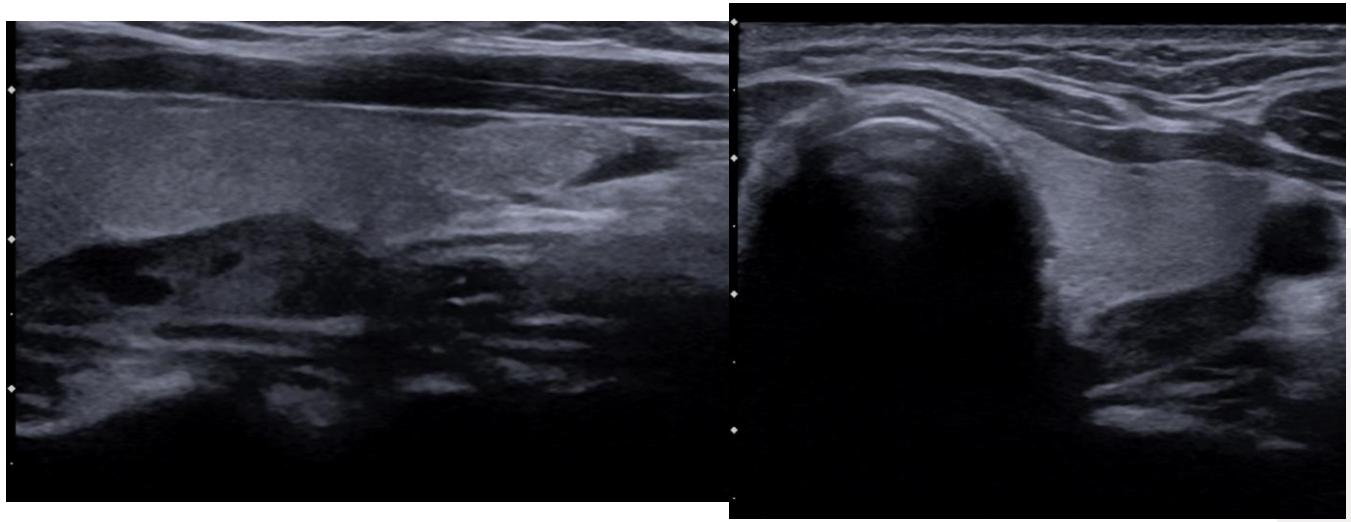
Parathyroid Glands

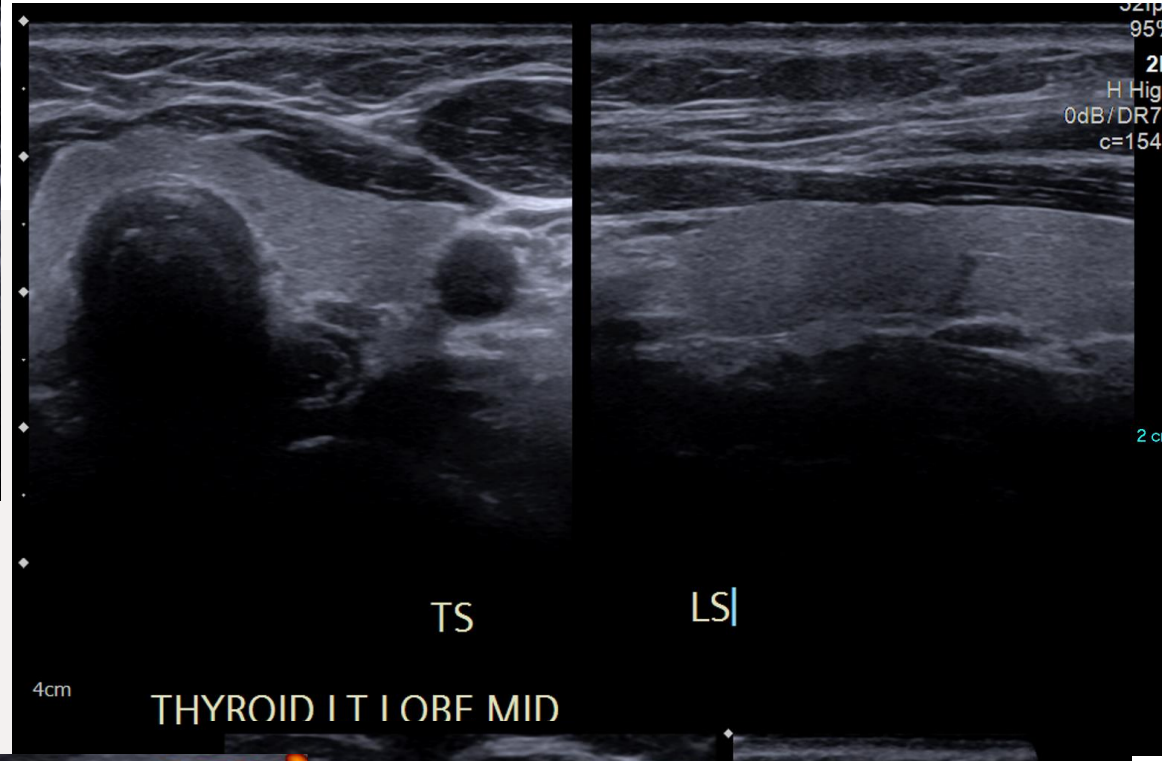


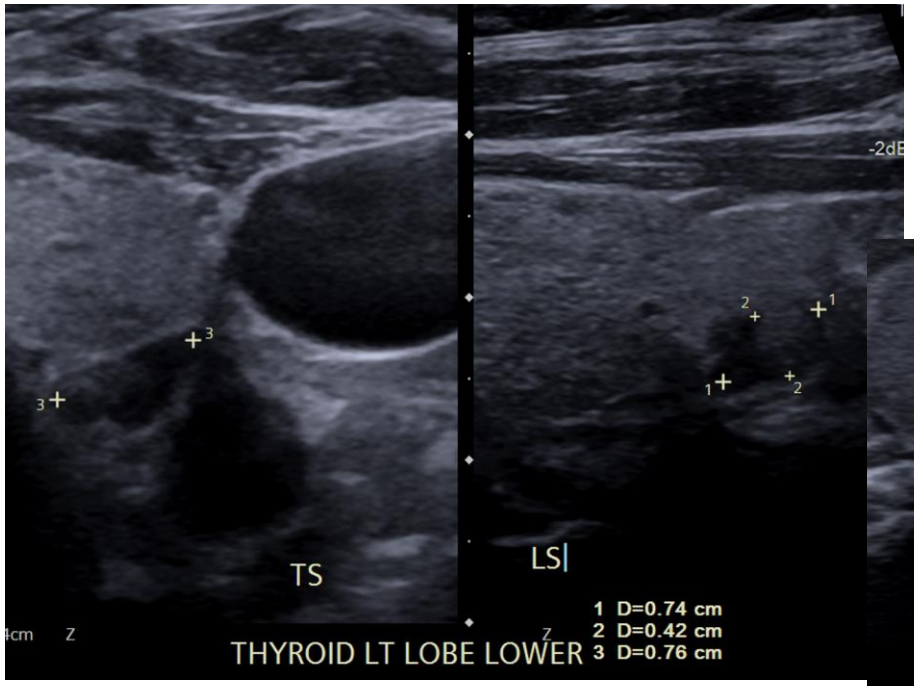


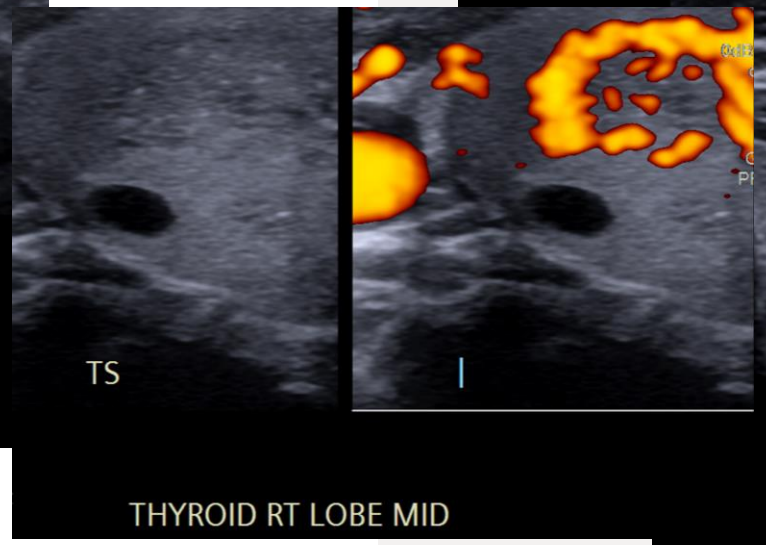


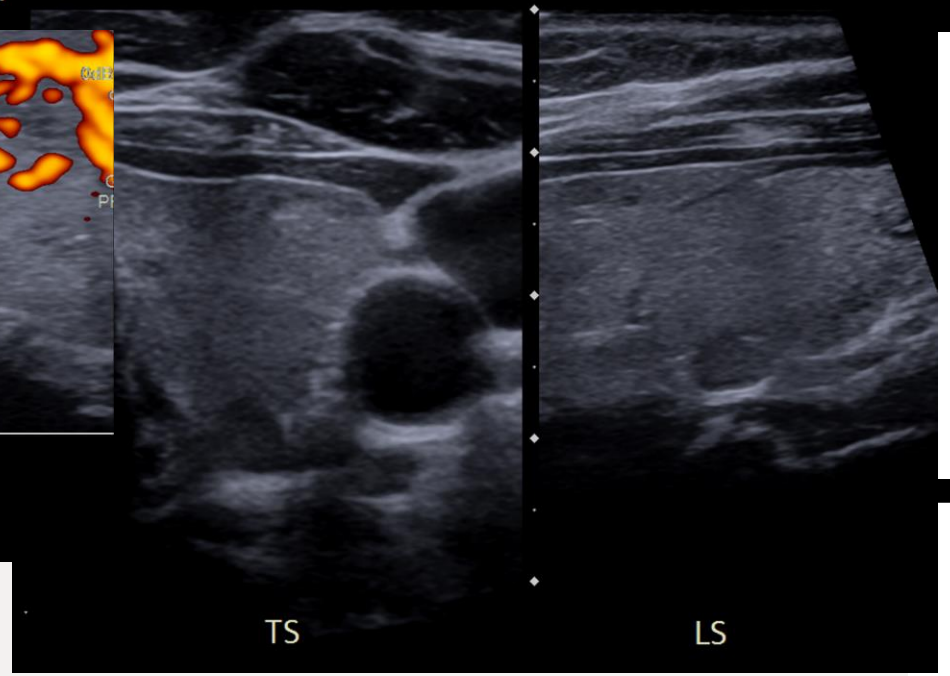


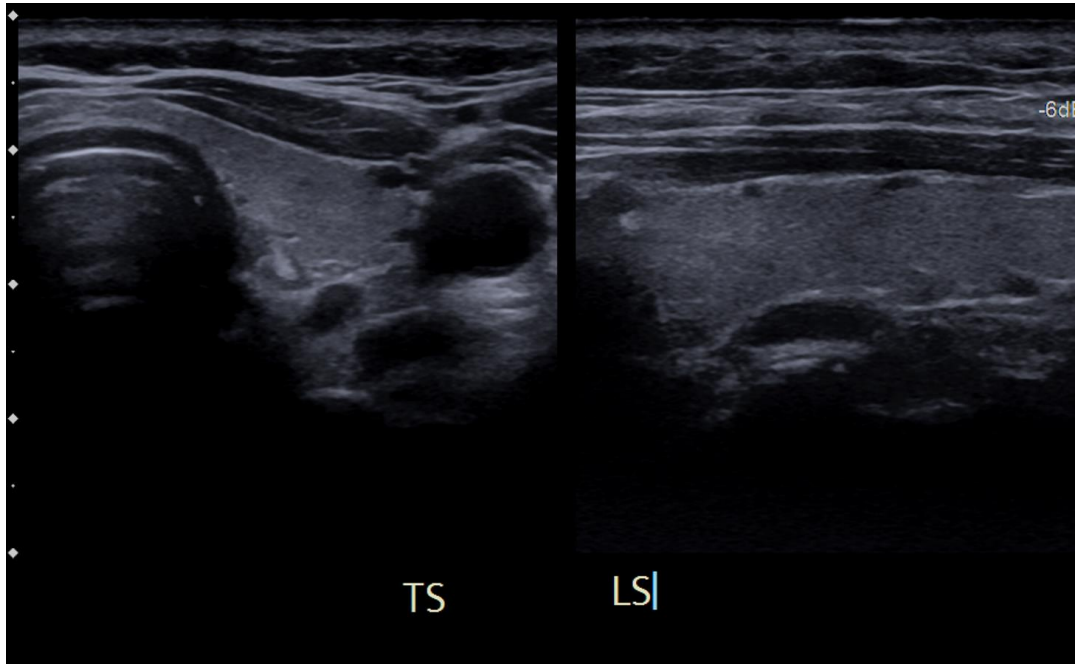


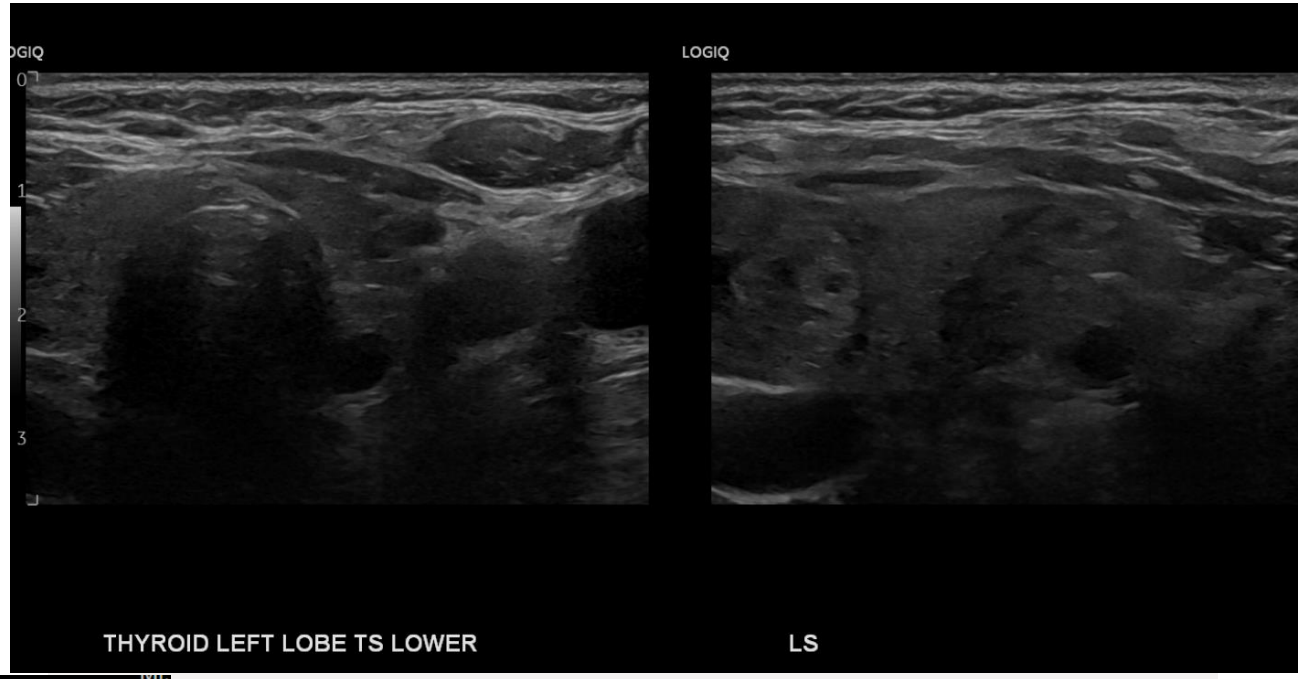

TS
LS
4cm
THYROID LT LOBE MID

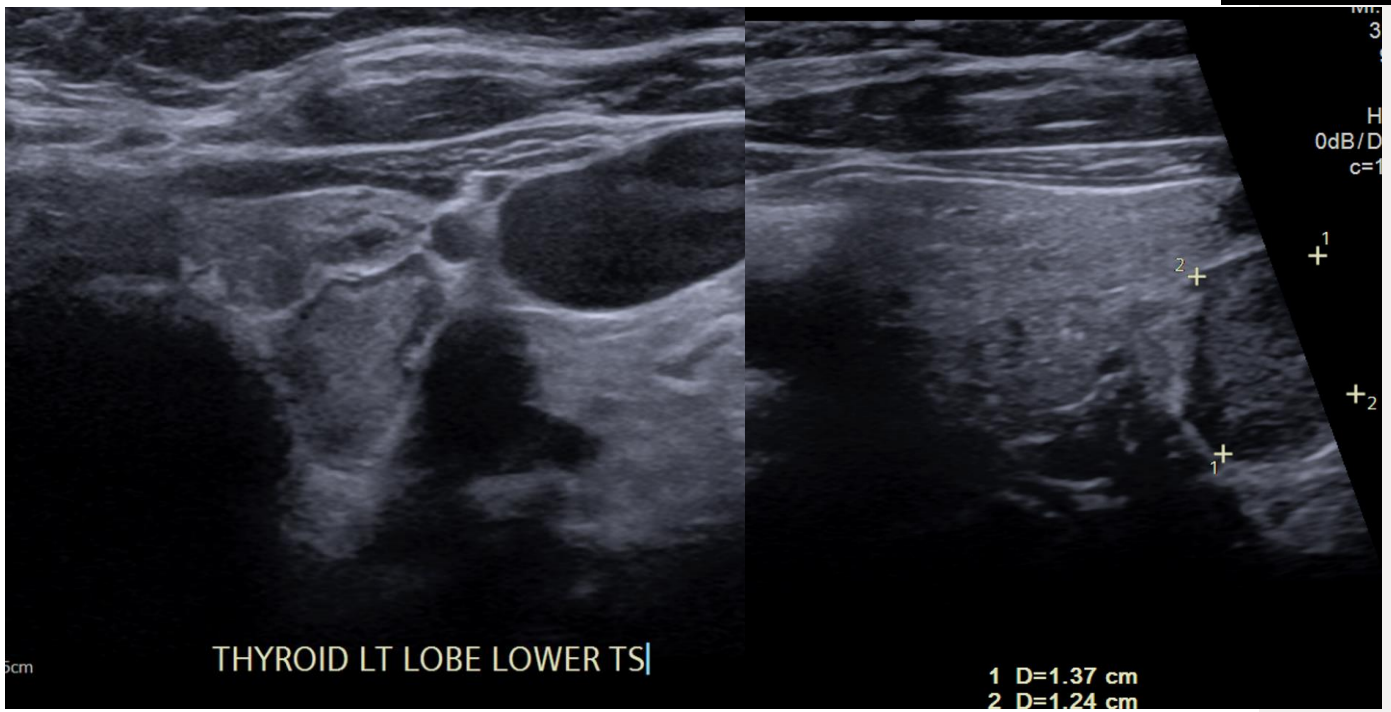

TS
LS
1 D=0.74 cm
2 D=0.42 cm
3 D=0.76 cm
THYROID LT LOBE LOWER

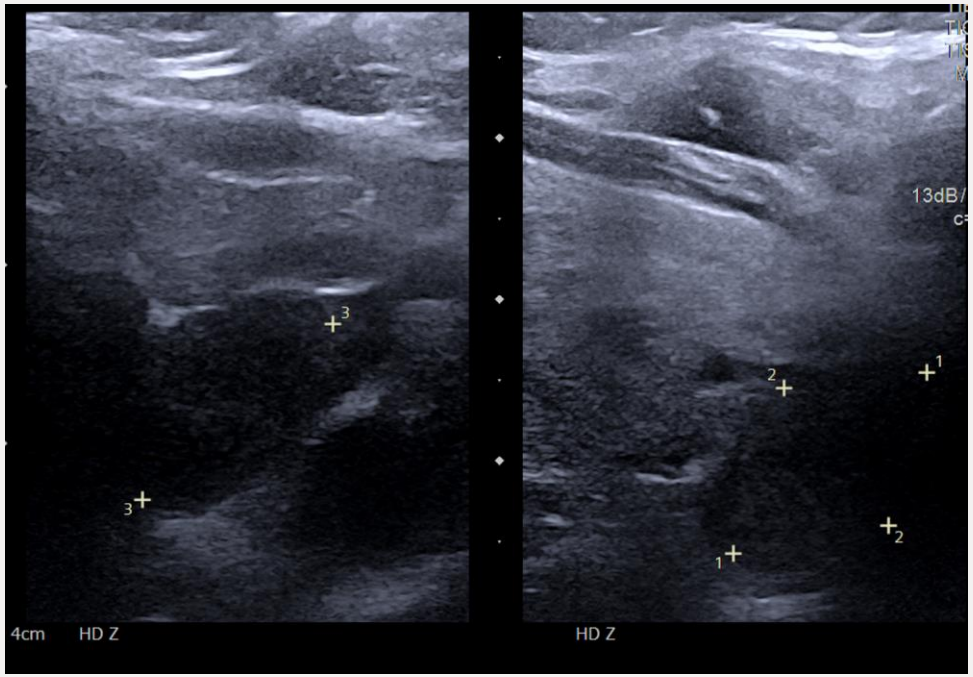

TS
THYROID RT LOBE MID

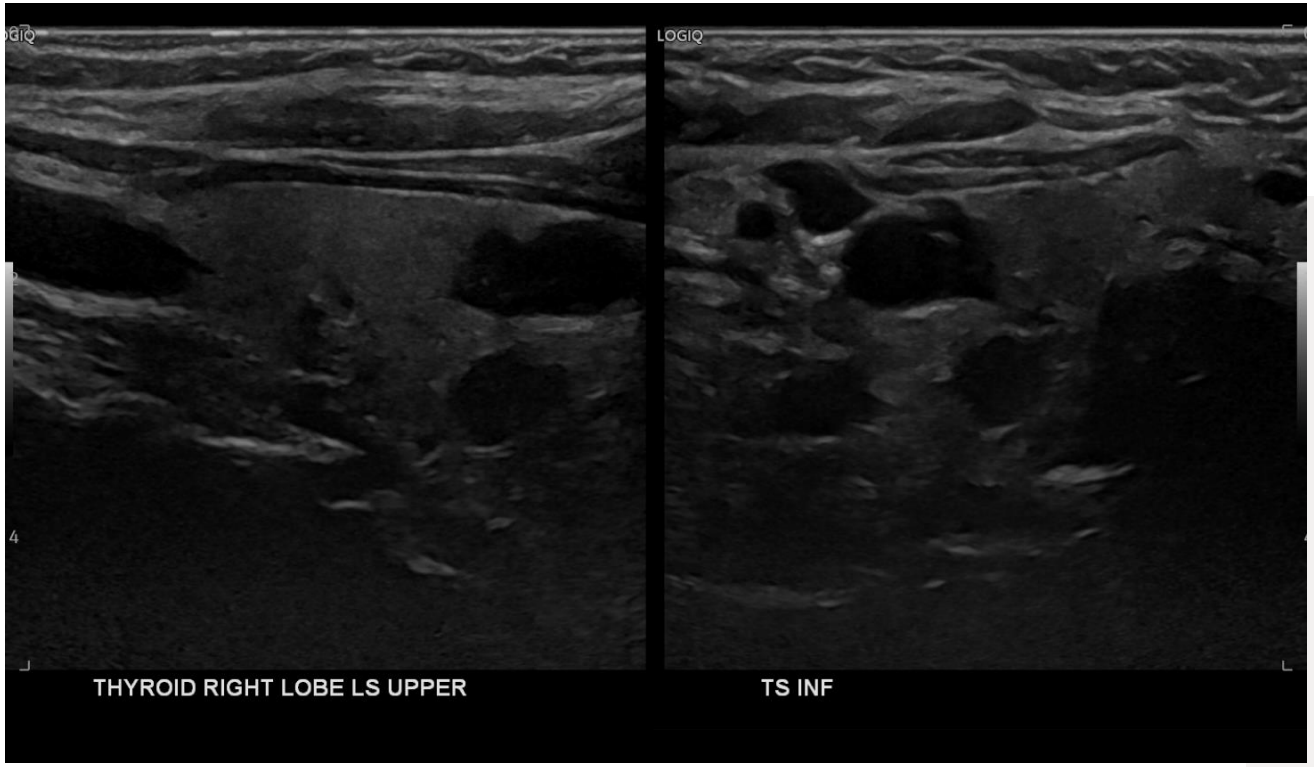

TS
LS


TS
LS


LOGIQ
LOGIQ
THYROID LEFT LOBE TS LOWER
LS


THYROID LT LOBE LOWER TS
1 D=1.37 cm
2 D=1.24 cm


4cm HD Z
HD Z


LOGIQ
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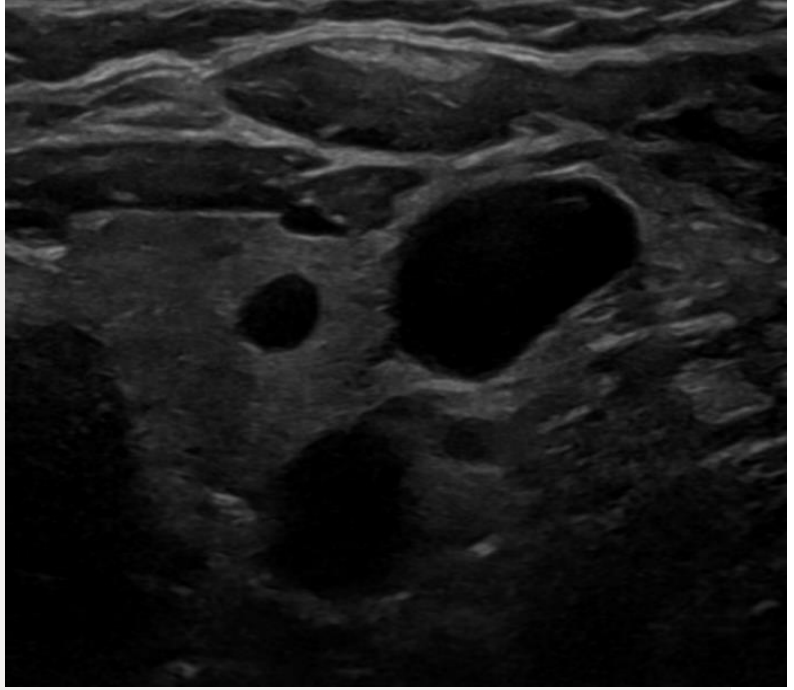
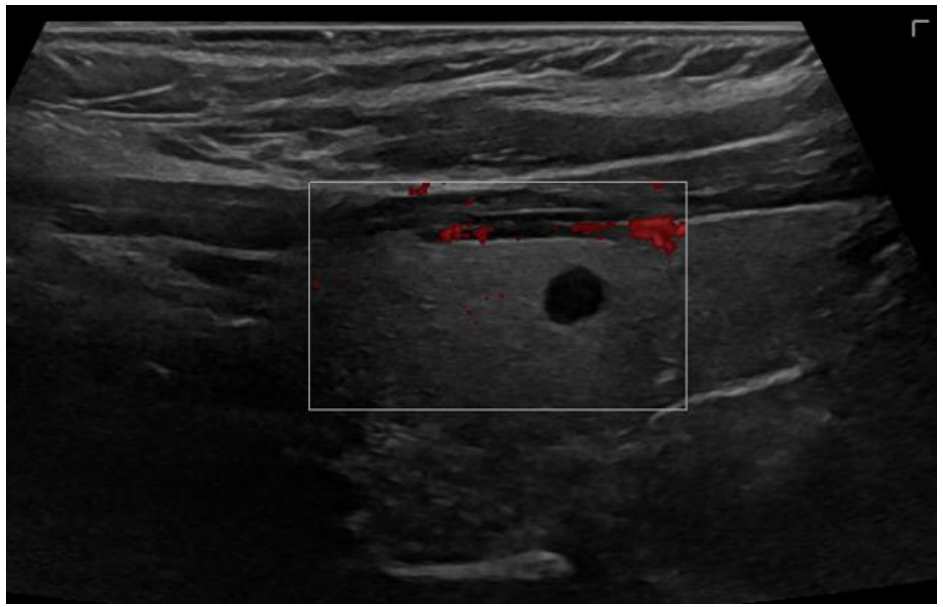
THYROID RIGHT LOBE LS UPPER
TS INF



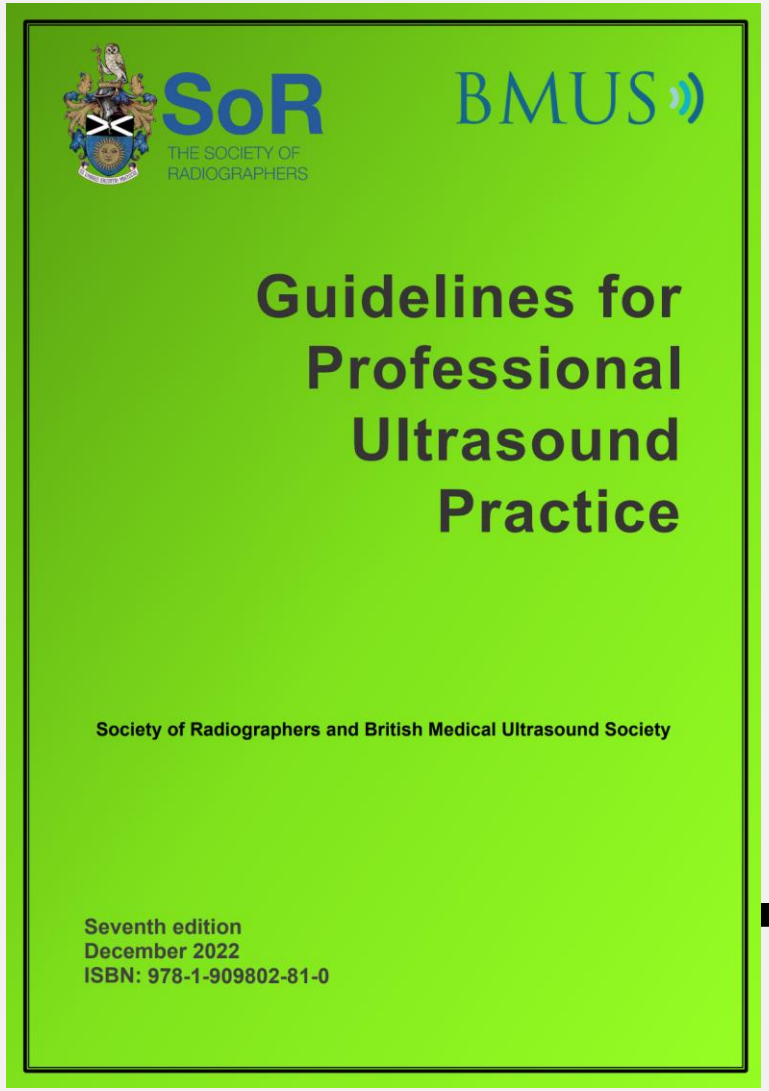



LOGIQ
THYROID LEFT LOBE LS

BMUS & SoR Guidelines for Professional Ultrasound Practice

Section 5.4 *“Head and neck ultrasound examinations”*

- General scanning principles
- Justification and clinical history
- Technique (including 7 sweeps)
- **BMUS Standards of practice**
- Common clinical scenarios
- FNAC/Core Bx
- Head and neck ultrasound reporting examples



H&N Level I Standards

BMUS

Head and Neck Ultrasound Practice Standards

Level I Standards to be aquired (will mainly be primary care referrals)	
General principles ☐	Recognise relationship of ultrasound with alternative head and neck imaging modalities Accurately issue reports on US examination performed Be aware of own limitations and recognise when to refer for a level II/III opinion

Competencies to be acquired	**Knowledge Base** **Major Salivary Glands:**
☐	Perform a thorough ultrasound examination of the parotid, submandibular and sublingual salivary glands in different planes
☐	Recognise normal ultrasound anatomy and common normal variants
☐	Recognise features of salivary gland calculi and obstructive sialectasis/sialadenitis
☐	Identify the limitations of US in the assessment of calculi/salivary obstruction
☐	Recognise the features of benign salivary neoplasm
☐	Recognise when a salivary mass does not have typical features of benignity
☐	Recognise salivary abnormalities that require discussion with a level II/III head and neck practitioner

H&N Level I Standards

BMUS

Head and Neck Ultrasound Practice Standards

	Cervical Lymph Nodes:
☐	Understand the anatomical boundaries of the main cervical lymph node groups
☐	Perform a comprehensive lymph node examination of the main groups
☐	Recognise the normal ultrasound architecture of cervical lymph nodes
☐	Recognise typical features of reactive lymphadenopathy
☐	Recognise abnormal ultrasound architecture and key features of malignant lymphadenopathy
	Major Vessels of the Neck:
☐	Recognise normal ultrasound anatomy and common normal variants
☐	Recognise features of venous thrombosis
	Thyroid:
☐	Perform a thorough multiplane ultrasound examination of the thyroid gland
☐	Understand the scoring system used locally (preferably the 2014 BTA U scoring system**) for assessment and characterisation of thyroid nodules and the indications for specialist referrals **Guidelines for the management of thyroid cancer

H&N Level II Standards

BMUS

Head and Neck Ultrasound Practice Standards

Level II Standards to be aquired , in addition to level I expectations (mainly primary care referrals and non-complex secondary care referrals)	
General Principles ☐	Recognise relationship of ultrasound with alternative head and neck imaging modalities Acuurately issue reports on US examination performed Be aware of own limitations and recognise when to refer for a level III opinion Audit of work
Competencies to be acquired ☐ ☐ ☐ ☐ ☐ ☐	**Knowledge Base:** (in addition to level I expectations) Governance issues and recommendations Sectional and ultrasound anatomy Detailed understanding of cervical neck anatomy including Superficial muscles of the head and neck Lymph node territories/groups Salivary gland variants Iatrogenic: anatomical changes following surgical resection of primary tumour and neck node dissection. Post radiotherapy changes. Granulomatous tissue formation. Benign

H&N Level II Standards

BMUS

Head and Neck Ultrasound Practice Standards

☐	thyroid pathology including haemorrhagic/cystic degeneration, thyroiditis, ectopic thyroid.
☐	Malignant thyroid processes including differentiated thyroid carcinoma, poorly differentiated and anaplastic thyroid carcinoma, lymphoma and metastasis
☐	Parathyroid pathologies
☐	Major salivary gland abnormalities including size and position of ductal calculi, ranula/sialocele, auto-immune sialadenitis, lymphoepithelial cysts, benign and maligant tumours, intraparotid lymphadenopathy
☐	Cervical lymph nodes normal and abnormal, features of extracapsular disease spread, lymphadenitis, supperative lymphadenopathy and abscess formation
☐	Miscellaneous including: congenital neck abnormalities, epidermal inclusion cyst,nerve sheath tumours, masseter hypertropy

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H&N Level III Standards

BMUS

Head and Neck Ultrasound Practice Standards

Level III Standards, in addition to level I and II expectations (referrals from all sources)	
General Principles	A more detailed understanding of head and neck imaging and pathology as detailed above, including understanding of head and neck oncology, thyroid oncology, current and developing surgical practices, head and neck radiotherapy and complex non-ultrasound imaging tecniques.
	Awareness of developments in head and neck ultrasound, including elastography and novel high-resolution techniques (e.g. intra-oral and intra-operative)
	Understanding of clinical examination techniques, interpretation of medical history and be able to triage effectively from this knowledge
Competencies to be acquired	A level III practitioner is likely to spend a significant amount of clinical time undertaking Head and Neck Ultrasound/Imaging, teaching, research and development and may be regarded as 'expert' in this area
	They will accept tertiary referrals from level I & II practitioners and will perform complex and specialised scans such as laryngeal restaging from ultrasound which cannot be achieved on CT or MRI in addition to ultrasound-guided invasive procedures
	They will be involved in mentorship and training of all levels
	They will be involved in local and regional MDTs
	They will be an essential resource for consultation on complex head and neck cases
	They will be able to refer to other imaging modalities and other investigations as required and make necessary referrals to medical collegues
	They will be an integral part of the interventional head and neck service

Example of Governance & Sign -off

Documentation of Additional Clinical Practice	XXXXXX Hospitals NHS Trust
Training & Competency	Head & Neck – Level I
Sonographer/Trainee/Radiologist	
Training completion date	
Clinical Supervisor	

NHS
Liverpool University Hospitals
NHS Foundation Trust

Fine Needle Aspiration Biochemistry for Parathyroid Localisation

Quick Reference Guide

Inclusion / Suitability

This investigation is not first line, being reserved for Re-do Neck Surgery or Patients at High Risk

There must be an identified suspect lesion on conventional imaging modalities that is suitable for US targeting that requires pre-operative confirmation of the nature of the lesion

All cases must be discussed and agreed at the Wednesday Lunchtime Endocrine Surgery MDT

Patient Counselling and Preparation

Patient to be informed about the nature of the investigation and the benefits v risk (as per any interventional procedure)

Specify on ICE USS request "agreed for Aspiration for PTH Biochemistry at MDT"

Radiology team to book as Interventional Radiology US slot at Aintree or Royal site, not available at Broadgreen

When scheduling, Radiology team to email Andrew Davidson & Sarah Davies
and cc Dutybiochemist@liverpoolft.nhs.uk to advise of date / time / site so lab can be prepared

US Procedure & Sample Handling

Aspirate under US guidance as per normal technique

The first pass sample (rather than a second) must be sent for biochemistry to minimise effects of blood on assay.

Needle to be washed with maximum 1ml of 0.9% Saline into a pale green top Lithium Heparin tube.

Use ICE Request "FLUID PTH" (from Endo & Oncology Tab) and state "Parathyroid gland aspirate" in free text box

Biochemistry Laboratory Processing

SOP for processing and dilution available in Lab: can be performed on an automated platform by any suitably trained biochemistry technician following this protocol

Standard reporting to ICE with disclaimer of non-accredited assay, interpret by referrer in conjunction with other tests. Also report Haem Index and any positive or negative effect on results from presence of haemolysed blood

Interpretation

Rediscuss results at MDT in context of other investigations, noting accuracy of targeting, PTH value and any assay interference, and compare to recent Serum PTH and Calcium

Excessive haem index reporting should prompt review to consider stopping/bridging anticoagulants

Feedback results from Surgery for Aspiration Localised PHPT at MDT and review any discrepancies

Parathyroid Protocol

– Priority of samples required:

1. PTH sample for Clinical Biochemistry

2. FNA aspirate into ThinPrep® CytoLyt®

3. FNA aspirate onto slide for morphology assessment

+

Difficult to confidently identify

Imaging for localisation only

At least two tests

Endocrine Surgeons only

Re-do surgery, increased risk

In Summary +

Parathyroid Ultrasound

Thank you for listening

Any questions?