Glossary

Echogenic/ Hypoechoic/Anechoic
Echogenicity is the ability of a tissue to reflect an ultrasound (US) wave. An echogenic structure will appear brighter on US (such as bone or tendon), whereas a hypoechoic structure will appear darker (such as fat).

Polar Vessel Sign
Enlarged vessel seen at the pole/end of an elongated, abnormal parathyroid gland (unlike lymph nodes where vessels enter at the hilum). Can be seen in US or 4DCT. [2]

Duke 4-dimensional CT scoring system of hyperfunctioning parathyroid glands
Type A: Enhancement greater than thyroid on arterial phase, any appearance on delayed.
Type B: Similar or lower than thyroid, washout on delayed
Type C: Neither enhancement nor washout. [3]

US/Color Doppler/Elastography [2]
1. Normal parathyroid glands are not visualized. A hyperplastic or adenomatous gland will appear as a hypoechoic oval, rounded, or lobulated solid lesion with an echogenic capsule.
2. Larger lesions can undergo cystic degeneration, appear anechoic, or have hemorrhage or calcification which will lead to increased echogenicity.
3. Color Doppler may demonstrate a ring of vascularity. Polar Vessel Sign may be seen.
4. Adenomas may have higher stiffness than hyperplastic nodules on elastography.

4DCT [2]
1. Normal parathyroid glands are arterially-enhancing soft tissue nodules with washout (usually ovoid).
2. Abnormal: According to Duke’s criteria, Type A & Type B enhancement with at least one additional finding is characteristic, without any additional finding is suspicious. Type C enhancement with additional finding is categorized as suspicious, without one is categorized as possible. Cystic degeneration or Polar Vessel Sign may also be seen.

Relevant Embryology & Pathophysiology [1]

Superior Parathyroids – Develop from fourth brachial pouch. Ectopic locations include tracheoesophageal groove, retroesophageal, parapharyngeal, intrathyroidal, or at the carotid sheath.

Inferior Parathyroids – Develop from third brachial pouch and can ectopically be found in thymus or thyroid gland, thymothyroid ligament, or submandibular gland. Rare locations include carotid bifurcation, posterior triangle of neck, supraclavicular neck, within the vagus or hypoglossal nerve, pericardium, or right dome of diaphragm.

Hyperparathyroidism can be primary with an autonomic hyperfunctioning adenoma; secondary with multiglandular hyperplasia as a result of organ failure; tertiary with development of an autonomous functioning gland(s) in long-standing renal failure. Each of these entities have a distinct biochemical profile.

On F-18 Fluorocholine (FCH) PET [3, 4]
1. Suggested mechanism of action: Upregulation of choline kinase in adenoma or hyperplasia leads to increase choline uptake which gets phosphorylated to phosphatidylcholine and trapped. Preferential uptake of FCH by any particular cell type is not known yet.
2. Focal uptake above the background with compatible target lesion on CT is considered positive for parathyroid adenoma
3. Potential false positives include thyroid uptake, faint uptake in normal glands, or uptake in normal or reactive or pathologic lymph nodes.
4. Emerging role in parathyroid adenoma imaging, in particular where first line imaging fails.

On MRI [2]
1. Normal T2 hyperintense, T1 intermediate to low intensity.
2. Usually ovoid.
3. Secondary changes including hemorrhage or fibrosis can present as increased signal on both T1 and T2W images.
4. Dynamic contrast enhanced imaging shows arterial enhancement with rapid washout in adenomas.

References
57 yo female presented with hypercalcemia. Fig 1a. Tc99 Sestamibi fused Axial SPECT-CT of the neck demonstrating no abnormal uptake to suggest any adenoma. Fig 1b demonstrating a left hypoechoic parathyroid nodule noted in ultrasound. Fig 1c, 1d, and 1e represent axial non-contrast, arterial, and delayed phase 4DCT images demonstrating an arterially-enhancing lesion (yellow arrows) (HU 218) with washout on delayed images (HU 88) compatible with an adenoma. The patient underwent resection and pathology was compatible with a parathyroid adenoma.

Further reading
1. Greenspan et al. SNM Practice Guideline for Parathyroid Scintigraphy 4.0*. DOI: 10.2967/jnmt.112.105122

CME Questions:
Q1: All are true about the embryology of the gland except:
A. Inferior parathyroid glands arise from third brachial pouch.
B. Superior parathyroid arise from fourth brachial pouch.
C. Inferior glands descend posteriorly and superior glands anteriorly.
D. Superior glands descend posteriorly and inferior glands descend anteriorly.

Q2: Which of the following is true for normal parathyroid imaging:
A. A hypoechoic oval, rounded, or lobulated solid lesion with an echogenic capsule on ultrasound/color Doppler/elastography.
B. Enhancement similar or lower than thyroid on arterial phase with washout on delayed phase on 4DCT.
C. Focal uptake above the background on F18 FCH PET.
D. T2 hyperintense and T1 intermediate to low intensity on MRI.