Parathyroid Sonography

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KEYWORDS

• Parathyroid adenoma • Hyperparathyroidism • Parathyroid hormone

KEY POINTS

- Ultrasonography plays a crucial role in preoperative localization of abnormal parathyroid glands to facilitate minimally invasive surgical techniques.
- The accuracy of ultrasonography in characterizing parathyroid disease is augmented by correlation with scintigraphy, although neither technique excels in multigland disease or after failed surgical resection.
- Cystic degeneration of parathyroid adenomas, parathyroid cysts, lipoadenomas, and parathyroid carcinoma are uncommon entities but could be encountered on sonography.
- Normal structures and other diseases may simulate parathyroid disease on sonography, including thyroid nodules and septa, cervical lymph nodes, and blood vessels.
- Fine-needle aspiration of parathyroid lesions for parathyroid hormone levels can be a useful adjunct to identify abnormal glands. Cytologic analysis of parathyroid lesions cannot consistently differentiate them from thyroid tissue.

DISCUSSION OF PROBLEM/CLINICAL PRESENTATION

Physiology

The parathyroid glands regulate calcium homeostasis by secretion of parathyroid hormone (PTH) from chief cells, which in turn increases renal reabsorption of calcium, decreases renal phosphate excretion, and stimulates osteoclasts. Hyperparathyroidism is classically categorized into primary, secondary, and tertiary subtypes. Although they may be asymptomatic, patients with hyperparathyroidism commonly present with symptoms of hypercalcemia, namely urinary tract stones, hypertension and abdominal and bone pain, as well as psychiatric symptoms, most commonly depression.

Primary Hyperparathyroidism

- Increased serum PTH and calcium levels
- Caused by parathyroid adenomas (90%), double adenomas (5%), hyperplasia (5%), and carcinomas (<1%)
- Treatment usually surgical excision
- Preoperative imaging commonly used

Primary hyperparathyroidism is caused by hyperfunctioning of the parathyroid glands themselves and manifests biochemically with abnormally increased serum levels of both PTH and calcium. Causes include adenomas, hyperplasia, and carcinoma of the parathyroid gland. This condition is most commonly caused by a single adenoma (approximately 90% of cases). Less commonly, it may occur in the setting of multigland disease, defined as either 2 adenomas (5%), or 4-gland hyperplasia (5%).[1,2] Parathyroid carcinoma accounts for less than 1% of cases of primary hyperparathyroidism and tends to produce worse laboratory abnormalities and more severe clinical symptoms.[2] Patients with multiple endocrine neoplasia (MEN) syndromes and other inherited causes of hyperparathyroidism comprise a small subset of primary hyperparathyroidism cases, occurring more commonly with type I MEN than in MEN IIA. Primary hyperparathyroidism is most

Disclosures: None.

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Ultrasound Clin 9 (2014) 339–349

http://dx.doi.org/10.1016/j.cult.2014.02.001

1556-858X/14/$ – see front matter

often treated with surgical resection of the hypersecreting gland or glands.

Secondary Hyperparathyroidism

- Increased serum PTH and decreased serum calcium levels
- Caused by glandular hyperplasia as a result of end-stage renal disease (ESRD), vitamin D deficiency
- Treatment usually medical
- Imaging use controversial

Secondary hyperparathyroidism is PTH oversecretion occurring in response to hypocalcemia, most commonly caused by chronic renal insufficiency and vitamin D deficiency. This condition typically manifests with multiglandular hyperplasia and biochemically with high serum PTH and low calcium levels. Medical management is the mainstay of treatment of secondary hyperparathyroidism, with only approximately 5% of ESRD requiring surgery after failed pharmacologic therapy.[3] Preoperative localization of parathyroid glands using ultrasonography or scintigraphy can be performed in select cases, such as with persistent hyperparathyroidism after subtotal resection, but its use before primary parathyroidectomy remains controversial because of the high likelihood of multigland disease and a wide range of accuracy in the literature.[4–8]

Tertiary Hyperparathyroidism

- Increased serum PTH and calcium levels
- Caused by persistent glandular hyperplasia after correction of causative disease
- Treatment commonly surgical
- Imaging use controversial

Tertiary hyperparathyroidism occurs when longstanding secondary hyperparathyroidism results in parathyroid hyperplasia that secretes PTH autonomously regardless of serum calcium level, usually in the setting of ESRD. This disorder remains despite correction of the underlying cause, classically seen as persistent hyperparathyroidism after renal transplantation. Biochemically, these patients have increased serum calcium and PTH levels, frequently accompanied by hyperphosphatemia. Total or subtotal parathyroidectomy is usually the treatment of choice for tertiary hyperparathyroidism. Similar to secondary hyperparathyroidism, preoperative imaging can be used in some cases, but it is not commonly used, because of the frequent need for bilateral neck exploration and the varying reported sensitivity in this setting.[4–8]

Surgical approach

Depending on the subtype of hyperparathyroidism that a patient has and the number of glands affected, bilateral neck exploration (in patients with multigland disease) or unilateral minimally invasive surgery may be performed. Minimally invasive parathyroidectomy with either radioguidance or serum PTH monitoring has decreased morbidity and shorter hospital stays than those observed with more radical dissections of the neck.[9,10] However, this approach relies on preoperative imaging, with precise localization of the abnormal gland. In patients with secondary or tertiary hyperparathyroidism, a subtotal parathyroidectomy may be performed to avoid hypoparathyroidism, in some cases with autologous transplantation of parathyroid tissue into the patient's forearm.

ANATOMY

- Normal parathyroid glands rarely seen by imaging
- Most patients have 4 glands (2 superior, 2 inferior)
- Inferior glands less predictable in location than superior glands and may be seen in the cervical thymus (26%) or mediastinum (2%)

The normal parathyroid glands are small and are rarely seen by imaging. The typical average size of the individual glands is approximately 5 × 3 × 1 mm and 40 to 50 mg.[11] Most patients have 4 glands (2 superior and 2 inferior), although approximately 3% to 5% of patients have a fifth gland.[12] The presence of fewer than 4 glands is rare, documented in less than 3% of patients.[13]

The superior parathyroid glands are closely associated with the thyroid gland, with a fairly predictable location posterior to the midthyroid (>90%). The superior glands may uncommonly be found more inferior than the midthyroid gland (4%), or above the superior margin of the thyroid (3%). Even less commonly, the superior parathyroid glands may be seen in retropharyngeal (1%), retroesophageal, or intrathyroidal locations (**Figs. 1** and **2**).[12–15]

The inferior glands are associated with the thymus, with a more variable location spanning from posterior to the midthyroid to the upper anterior and middle mediastinum. The inferior parathyroids are most commonly seen inferior, posterior, or lateral to the lower thyroid pole (69%). However, they are often seen in the cervical portion of the thymus (26%), mediastinum (2%), or rarely in the carotid sheath (see **Fig. 1**; **Fig. 3**).[12–15]