Why Thyroid Surgeons Are Frustrated with Radiologists: Lessons Learned from Pre- and Postoperative US[1]

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Abbreviations: ATA = American Thyroid Association, DTC = differentiated thyroid cancer, FNA = fine-needle aspiration

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- Recognize what information is desired by thyroid surgeons in pre- and postoperative neck US reports.
- Identify how best to communicate this information by using report templates and line diagrams.
- Describe normal and abnormal US appearances after thyroidectomy.

See www.rsna.org/education/search/RG.

Optimal treatment of thyroid cancer is highly dependent on accurate staging of the extent of disease at presentation. Preoperative ultrasonography (US) is the most sensitive method for detecting metastatic lymph nodes and is recommended as part of the standard preoperative workup. Missed findings on preoperative scans may lead to understaging and inadequate surgical management, which subsequently predispose these patients to residual disease postoperatively and a higher risk for recurrence, possibly requiring repeat surgery. Traditionally, thyroid US for pre- and postoperative staging has been performed by radiologists. However, there is a growing trend away from radiologist-performed US in favor of surgeon-performed US. Recent surgical and endocrinology literature has shown that, when compared with surgeon-performed US, radiologist-performed preoperative staging US is less accurate and is inadequate for presurgical planning, with higher local recurrence rates. This review highlights the importance of accurate preoperative US for patients with differentiated thyroid cancer, with specific attention to deficiencies that exist in general radiology department thyroid US reports. We present a standardized approach to neck US reporting that incorporates the newly updated 2015 recommendations from the American Thyroid Association and also addresses the pertinent questions for thyroid surgeons. By ensuring comprehensive preoperative assessment and improving thyroid US reporting, we seek to improve patient access to optimized care.

Introduction

Differentiated thyroid cancer (DTC) accounts for 90% of all thyroid cancers, mostly consisting of papillary thyroid cancer (1). Lymph node metastasis is very common, reportedly occurring in 30%–80% of patients with DTC, depending on the detection method (2). The presence of metastatic lymph nodes is the most common risk factor for recurrence, with most recurrences occurring within the first 5 years postoperatively, suggesting that they represent occult metastases that were not detected and not resected at the initial surgery (1–3). Physical examination has shown poor sensitivity in detection of small lymph nodes, which highlights the need for accurate preoperative imaging and detection to ensure comprehensive initial resection (4).

Preoperative ultrasonography (US) is the most sensitive method for detecting metastatic lymph nodes and, as such, is recommended as part of the standard preoperative workup by the American Thyroid Association (ATA) and the National Comprehensive Cancer Network (NCCN) (3). Traditionally, thyroid US for pre- and

TEACHING POINTS

- Radiologists must identify bilateral suspicious nodules preoperatively because cancer in both thyroid lobes necessitates a total thyroidectomy rather than a lobectomy.
- Failure to assess for and report local invasion of adjacent structures has a negative effect on disease management by failing to prepare the surgeon and patient for a more complex surgical procedure and the increased risk for recurrence and metastases.
- Failure to report intrathoracic extension of the thyroid gland may adversely affect surgery as complete resection of thyroid tissue may not be possible through a cervical incision.
- Comprehensively evaluating the cervical lymph nodes is a mandatory component of US in patients with known or suspected thyroid cancer (including those with a suspicious nodule), as cervical lymph node status determines the type of surgery performed and affects prognosis.
- Use of a standardized reporting template will ensure that all fields are addressed and all key findings commented on, especially if there are multiple sonographers and radiologists caring for patients with thyroid cancer.

postoperative staging has been performed by radiologists. However, there is a growing trend away from radiologist-performed US in favor of surgeon-performed US, which is seen as a natural extension of the preoperative physical examination. Recent surgical and endocrinology literature has shown that, when compared with surgeon-performed US, radiologist-performed preoperative staging US is less accurate and is inadequate for presurgical planning, with higher associated local recurrence rates (5–7). Key deficiencies observed include failure to assess for abnormal cervical lymph nodes, missed contralateral thyroid nodules, missed extrathyroidal invasion, and missed intrathoracic extension of the thyroid gland (6).

Optimal treatment of thyroid cancer depends overwhelmingly on accurate staging of the extent of disease at presentation. Missed findings on preoperative scans may lead to understaging and inadequate surgical management, which subsequently predispose these patients to residual disease postoperatively and a higher risk for recurrence, which may then require repeat surgery. This review highlights the importance of accurate preoperative US for patients with DTC, with specific attention to deficiencies that exist in the general radiologist's thyroid US report. We present a standardized approach to neck US reporting that incorporates the newly updated 2015 recommendations from the ATA and addresses the pertinent questions for thyroid surgeons. By ensuring comprehensive preoperative assessment and improving thyroid US reporting, we seek to improve the value of radiologist-performed US and thereby help to optimize patient care.

Neck Anatomy

Cervical lymph nodes are divided into seven levels on the basis of their anatomic location (Fig 1) (Table 1). The lymph node levels reflect a consensus opinion on the basis of the pathophysiology of head and neck cancer and are intended to standardize the terminology for lymph node dissections and allow consistent communication among care providers (8). The anatomic and surgical landmarks have subsequently been validated for an imaging-based lymph node classification, with landmarks that can be reliably visualized during axial imaging (9). Lymph nodes within level VI are the most commonly involved in thyroid cancer (10). Metastatic lymph nodes in the lateral neck (II–V) are less common but may be associated with a worse prognosis (2).

Surgical Technique

The type of surgery for thyroid cancer depends on the size of the malignant nodule as well as the presence or absence of contralateral thyroid nodules, regional lymph node involvement, and metastatic disease. A total thyroidectomy results in complete surgical resection of all visible thyroid tissue and is typically performed in patients with a cancerous nodule larger than 4 cm, extrathyroidal extension, or regional or distant metastatic disease (11). Total thyroidectomy is also performed if the patient has a history of head and neck radiation therapy or a family history of thyroid cancer (11). A near-total thyroidectomy involves resection of all thyroid tissue except for a small amount adjacent to the recurrent laryngeal nerves and can be considered in this same subset of patients. In contrast, a hemithyroidectomy or a lobectomy removes only a single lobe with the isthmus and is the standard procedure in patients with a thyroid cancer smaller than 1 cm, no extrathyroidal extension, and no metastatic disease (11). In the updated 2015 ATA guidelines, lobectomy can also now be considered in patients with a thyroid cancer that is 1–4 cm, no extrathyroidal extension, and no metastases (11). In this setting, choosing the appropriate procedure requires consideration of the surgical risks in total thyroidectomy, such as bilateral recurrent laryngeal nerve injury and/or permanent hypocalcemia, which are not present with lobectomies (12).

Cervical lymph node dissection is a key component of surgical management in patients with thyroid cancer, and several different types may be considered. Neck dissection terminology reflects a multispecialty consensus classification scheme established by the American Head and Neck Society, with radical neck dissection considered to be the standard basic procedure for lymphadenectomy from which other modifications are derived (13). Radical neck dissection involves resection of

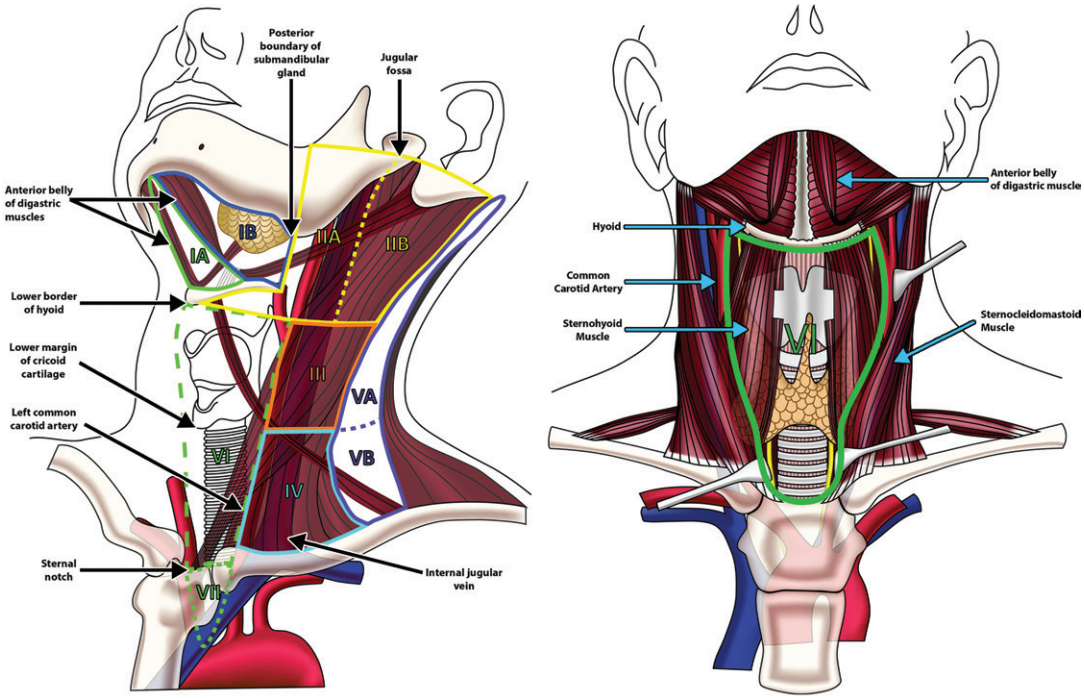


Figure 1. Cervical lymph nodes. **(a)** Oblique lateral diagram shows the cervical lymph nodes and the relevant anatomy. **(b)** Anterior diagram shows the borders of lymph node level VI (green outline).

Table 1: Anatomic Boundaries of Cervical Lymph Node Levels I–VI

Cervical Level	Superior	Inferior	Anterior (Medial)	Posterior (Lateral)
IA	Mandible	Hyoid bone	Anterior belly of the contralateral digastric muscle	Anterior belly of the ipsilateral digastric muscle
IB	Mandible	Hyoid bone	Anterior belly of the digastric muscle	Stylohyoid muscle
IIA	Skull base	Horizontal plane of the inferior body of the hyoid bone	Stylohyoid muscle	Vertical plane of the spinal accessory nerve
IIB	Skull base	Horizontal plane of the inferior body of the hyoid bone	Vertical plane of the spinal accessory nerve	Lateral border of the SCM
III	Horizontal plane of the inferior body of the hyoid bone	Horizontal plane of the inferior border of the cricoid cartilage	Lateral border of the sternohyoid muscle	Lateral border of the SCM
IV	Horizontal plane of the inferior border of the cricoid cartilage	Clavicle	Lateral border of the sternohyoid muscle	Lateral border of the SCM
VA	Apex of the SCM and trapezius muscles	Horizontal plane of the lower border of the cricoid cartilage	Posterior border of the SCM	Anterior border of the trapezius muscle
VB	Horizontal plane of the lower border of the cricoid cartilage	Clavicle	Posterior border of the SCM	Anterior border of the trapezius muscle
VI	Hyoid bone	Suprasternal	Common carotid artery	Common carotid artery

Note.—SCM = sternocleidomastoid muscle.

ipsilateral cervical lymph nodes from the mandible to the clavicle (levels I–V), along with the spinal accessory nerve, sternocleidomastoid muscle, and internal jugular vein. When additional lymph node groups or nonlymphatic structures are resected along with the standard radical neck dissection, the surgery is referred to as an extended radical neck dissection. A modified radical neck dissection refers to removal of lymph node levels I–V, with preservation of one or more nonlymphatic structures (eg, the internal jugular vein). Depending on the site of the primary cancer and the pattern of metastatic cervical lymphadenopathy, one or more lymph node groups may be preserved, and the procedure is then termed a *selective neck dissection*. For example, a central compartment neck dissection is a specific type of selective neck dissection (level VI) reflecting the most common location for lymph node metastases in patients with thyroid cancer (10). Likewise, a lateral compartment neck dissection refers to the removal of lymph nodes from levels II, III, IV, and V and is typically reported by designating the side and nodal levels and/or sublevels dissected (2).

Sonographic Technique

Consistent US technique is crucial to ensure a comprehensive assessment in all patients. For a detailed description of US of the thyroid gland and cervical lymph nodes, readers are referred to the collaborative practice guidelines established by the American Institute of Ultrasound in Medicine (AIUM), the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU) (14). In brief, scanning is performed with the patient supine and the neck in slight hyperextension, which can be facilitated by using a rolled towel placed under the shoulders. A high-frequency (12–15 MHz) linear transducer is preferable for high-resolution imaging of these superficial structures. In patients with substantial subcutaneous tissue and/or large thyroid glands, a lower frequency or a curved transducer can be used to optimize spatial resolution and penetration.

Both thyroid lobes and the thyroid isthmus are typically imaged sequentially in the transverse and longitudinal planes. Central compartment (level VI) lymph nodes are imaged from the submental region to the sternal notch. Lateral compartment (levels II–V) lymph nodes are imaged from the angle of the mandible to the clavicle, following the vagus-carotid jugular sheath inferiorly. When possible, abnormal lymph nodes are denoted on the basis of their level. However, other anatomic landmarks, such as distance from the sternal notch or clavicular head, are also commonly used because identifying landmarks such as the cricoid cartilage can be difficult to note sonographically.

Preoperative Neck US

For patients with known or suspected thyroid cancer, comprehensive US must assess both the thyroid gland (including the primary tumor and additional nodules) and the cervical lymph nodes. This is of primary importance, as disease recurrence following resection of DTC is frequently attributed to incomplete initial surgery and unresected residual disease, which may be related to inadequate preoperative imaging (3).

Thyroid

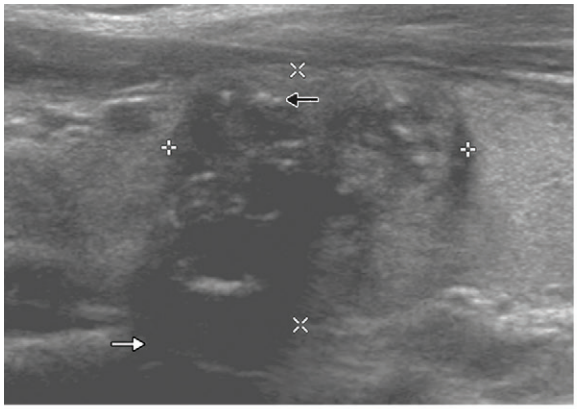
Thyroid nodules are a common clinical problem and are detected sonographically (reported in 19%–68% of a randomly selected adult population), although the majority are benign (11,15,16). Using size and suspicious sonographic features, both the ATA and SRU have offered recommendations for which nodules should undergo fine-needle aspiration (FNA), which are summarized in Table 2. Nodules that are solid, hypoechoic, and taller than wide with irregular margins, microcalcifications, disrupted rim calcifications, or extrathyroidal extension are highly likely to represent papillary thyroid cancer (Figs 2, 3) (11). Notably, microcalcifications have been shown to have a sensitivity of 89%, specificity of 95%, and accuracy of 94% for detection of malignant thyroid nodules (18). In a systematic review and meta-analysis of suspicious sonographic features used to predict malignant potential, reported sensitivities and specificities were, respectively, 87% and 56% for solid nodules, 73% and 56% for hypoechoic nodules, 53% and 93% for nodules taller than they were wide, and 59% and 79% for nodules with infiltrative margins (19). Taller-than-wide shape has a high specificity for thyroid cancer, but a low sensitivity, especially in larger nodules (20,21). Table 2 lists the risk estimates for malignancy of thyroid nodules on the basis of the sonographic features, which are derived from data from high-volume institutions (11).

As DTC (especially papillary) is frequently multifocal, multiple nodules may require FNA to ensure appropriate surgical planning, particularly given the expanded considerations for lobectomy in the 2015 ATA guidelines (11). Each nodule larger than 1 cm should be evaluated independently, and FNA should be considered for any nodules that meet sonographic criteria. This is particularly important if there are suspicious nodules in both lobes, because bilateral cancers would require total thyroidectomy rather than lobectomy. However, failure to identify contralateral or

Table 2: SRU and ATA Size Guidelines for FNA of Thyroid Nodules according to US Findings and ATA Malignancy Risk Estimates (11,17)

US Findings	SRU 2005 (cm)	ATA 2015 (cm)	Malignancy Risk (%) (ATA 2015)
Nodule with microcalcifications	≥1.0	≥1.0	>70–90
Solid nodule			
Hypoechoic with suspicious features*	≥1.5	≥1.0	>70–90
Hypoechoic without suspicious features	≥1.5	≥1.0	10–20
Isoechoic or hyperechoic	≥1.5	≥1.5	5–10
Mixed cystic and solid			
Suspicious features* of solid component	≥2.0	≥1.0	>70–90
Without suspicious features	≥2.0	≥1.5	5–10
Spongiform without suspicious features	...	≥2.0	<3

*Suspicious features include irregular margins (infiltrative, microlobulated, spiculated), microcalcifications, taller than wide, rim calcifications with a small extrusive soft-tissue component, and evidence of extrathyroidal extension.



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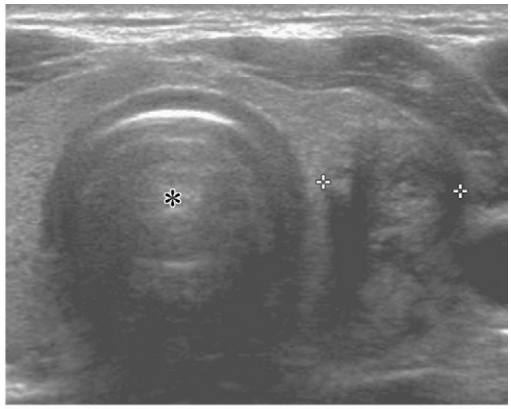

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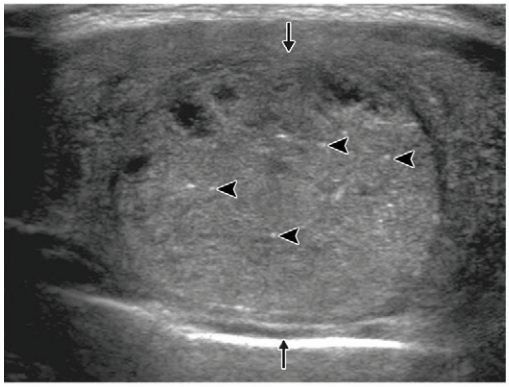

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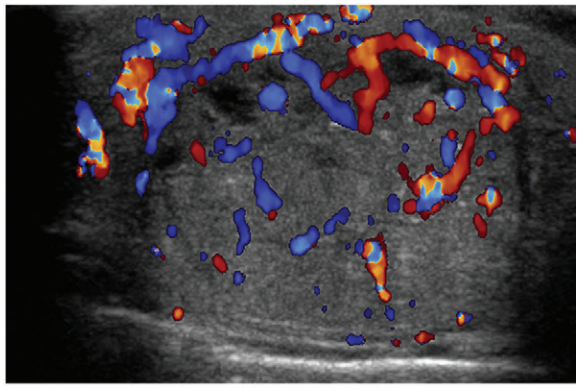
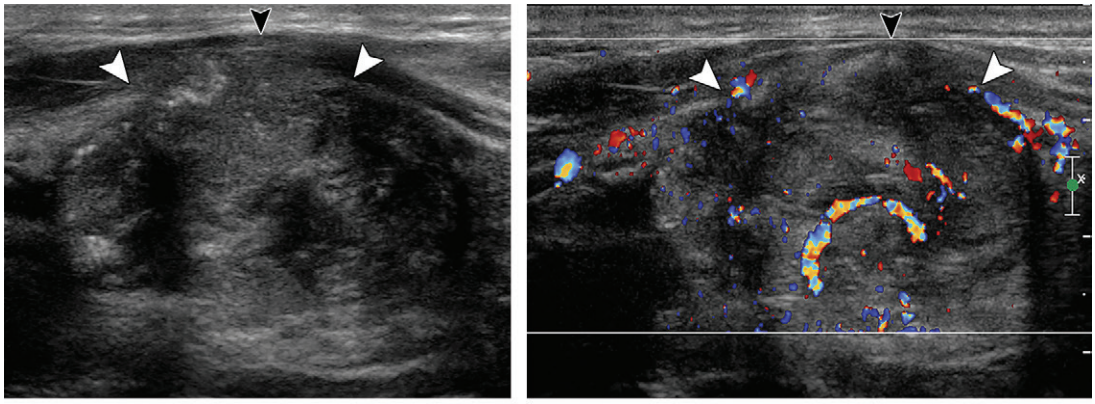


3b.

Figures 2, 3. **(2)** Left papillary thyroid cancer in a 42-year-old woman. **(a)** Sagittal gray-scale US image demonstrates microcalcifications (black arrow) in a hypoechoic left thyroid nodule, which was sampled at FNA and confirmed to be papillary thyroid cancer. Shadowing (white arrow) of the posterior wall makes extracapsular extension determination difficult. **(b)** Transverse gray-scale US image shows that the nodule is taller than wide. There is normal thyroid tissue between the nodule and the trachea (*). **(3)** Right papillary thyroid cancer in a 31-year-old woman. **(a)** Sagittal gray-scale US image shows a 3-cm isoechoic solid nodule (arrows) with microcalcifications (arrowheads), a finding confirmed to be papillary thyroid cancer at FNA. **(b)** Color Doppler US image of the same nodule demonstrates increased central and peripheral vascularity, a feature that is commonly seen in malignant nodules.

bilateral thyroid nodules has been reported to be a shortcoming of radiologist-performed thyroid US and can result in inappropriate surgical management. In a retrospective study of 136 patients with thyroid cancer, US performed by radiologists missed contralateral nodules in 16 of 74 patients (22%) in whom bilateral nodules were present (6). In another retrospective study of 334 patients with



a. b.

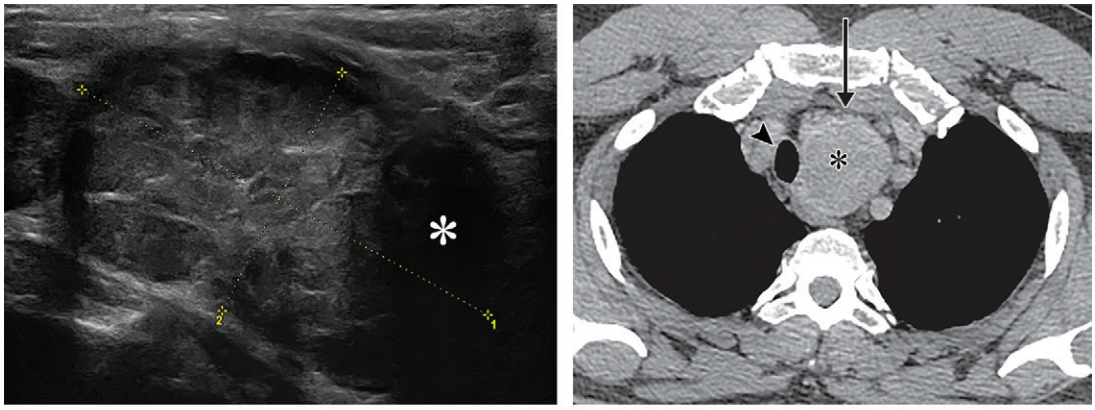
Figure 4. Extracapsular extension of a right papillary thyroid cancer in a 25-year-old man. **(a)** Gray-scale US image demonstrates a 3.8-cm heterogeneous solid nodule with indistinct anterior margins (white arrowheads) and invasion of the overlying strap muscle (black arrowhead), which was confirmed intraoperatively. **(b)** Color Doppler US image demonstrates central and peripheral hypervascularity with extracapsular extension (white arrowheads) and strap muscle invasion (black arrowhead).

thyroid disease, contralateral nodules were missed in two patients and were subsequently detected at surgeon-performed US (5). Radiologists must identify bilateral suspicious nodules preoperatively because cancer in both thyroid lobes necessitates a total thyroidectomy rather than a lobectomy.

Extracapsular extension of thyroid malignancy and retrosternal extension of thyroid tissue or malignancy are critical features affecting both management and outcome; unfortunately, both have been shown to be underreported by radiologists.

Extracapsular extension is a high-risk feature, as it is associated with an increased incidence of both metastasis and local disease recurrence (22). Moreover, preoperative imaging detection of gross extracapsular extension is an important factor in proper surgical planning to ensure complete resection (near-total or total thyroidectomy rather than lobectomy) and also prepares the patient for the likelihood of postoperative adjuvant radioactive iodine therapy (11). Extrathyroidal extension from the posterior capsule or into the mediastinum would also prompt further evaluation with computed tomography (CT), as well as a preoperative laryngeal examination, to fully characterize local invasion and extent (11). US features of extracapsular disease range from subtle extension of the lesion beyond the thyroid borders to obvious involvement of extrathyroidal structures (Fig 4). Locally, the strap muscles are most commonly involved and warrant specific attention by the sonographer (Fig 4) (11). However, one study demonstrated that radiologists missed extracapsular extension of thyroid cancer in six of 136 patients (five with local strap muscle invasion, one with jugular vein tumor thrombus) (6). Failure to assess for and report local invasion of adjacent structures has a negative effect on disease management by failing to prepare the surgeon and patient for a more complex surgical procedure and the increased risk for recurrence and metastases.

Preoperative documentation of substantial retrosternal extension of the thyroid (normal tissue and nodules) is also crucial because it may radically alter the surgical plan, potentially requiring sternotomy in addition to the standard cervical approach for complete thyroidectomy. Although thyroidectomies requiring sternotomy are rare, they can be associated with serious complications such as subcutaneous abscess, chylothorax, and pneumothorax, which are important for patients and surgeons to recognize preoperatively (23). Unfortunately, retrosternal extension of the thyroid is another finding infrequently reported by radiologists. For example, a retrospective study demonstrated intrathoracic extension of the thyroid gland in five of 136 patients, all of which were missed at radiologist-performed US but subsequently detected at surgeon-performed US (6). Failure to report intrathoracic extension of the thyroid gland may adversely affect surgery as complete resection of thyroid tissue may not be possible through a cervical incision. Therefore, radiologists and sonographers must clearly demonstrate the lower margin of both thyroid lobes and suspicious nodules at all preoperative US examinations, as lack of visualization of the lower margin suggests retrosternal extension (Fig 5). In difficult cases, imaging during patient swallowing may help to visualize the caudal margin of the gland. If substernal extension is suggested or demonstrated at US, thoracic CT is typically recommended to aid in surgical planning (Fig 5). Patients' arm positioning during CT affects the retrosternal extent of the thyroid gland in that



a. b.

c.

Figure 5. Intrathoracic extension of an 8.5-cm left papillary thyroid cancer in a 60-year-old man. **(a)** Sagittal gray-scale US image demonstrates a large left thyroid nodule with incomplete visualization (*) of the inferior margin. **(b, c)** Axial **(b)** and coronal **(c)** chest CT images demonstrate the degree of intrathoracic extension (*) of the left papillary thyroid cancer (arrow in **b**), including displacement of the trachea (arrowhead) to the right, as well as a metastatic mediastinal lymph node (arrow in **c**).

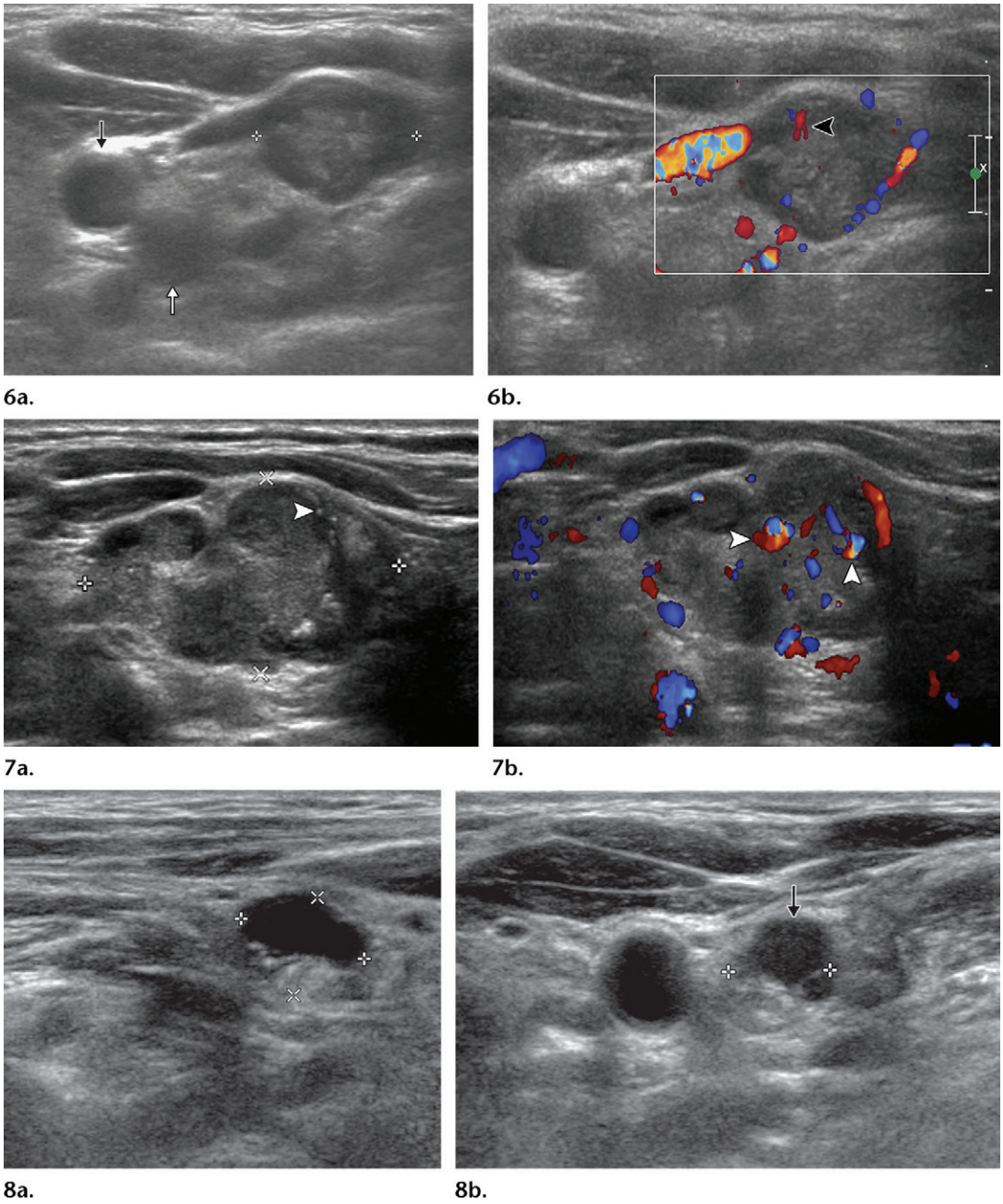
greater retrosternal extension is visualized when scanning is performed with their arms above their head than at their side. Therefore, CT should be performed with the patient's arms at the side as this position represents the true location of the gland (24).

Cervical Lymph Nodes

Regional lymph nodes are present in a majority of patients with DTC (most commonly level VI). During preoperative assessment, clinical neck examination may identify large-volume adenopathy but is relatively insensitive for detection of small-volume disease. In one series, preoperative US altered the surgical approach in 23% of patients, both by identifying metastatic lymph nodes that were occult at physical examination and also by demonstrating no suspicious lymph nodes in patients in whom cervical lymph nodes were suspected at physical examination (1). Therefore, proper staging of thyroid cancer relies heavily on accurate sonographic assessment and identification of suspicious cervical lymph nodes.

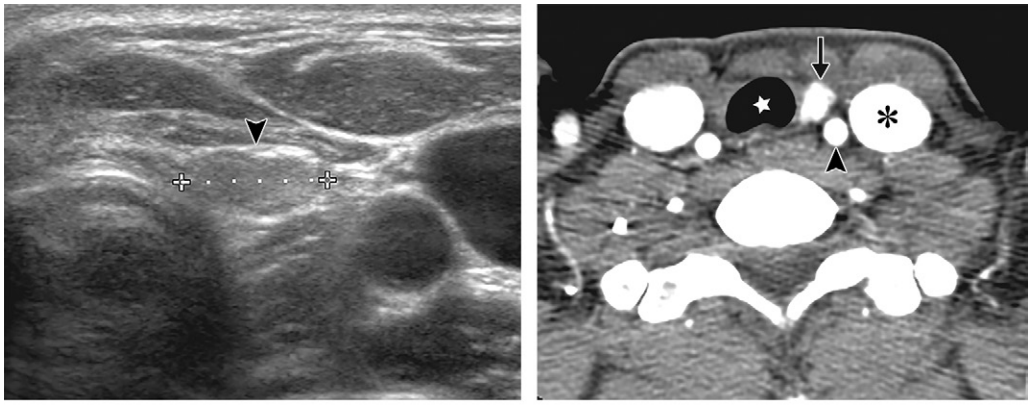
Sonographic features suspicious for metastatic lymph nodes include microcalcifications, cystic degeneration, increased peripheral vascularity, echogenicity greater than that of adjacent musculature, rounded morphology (long-to-short-axis ratio <2), and loss of the fatty hilum—noting that no single feature is adequately sensitive or specific in isolation (Figs 6–8) (11,25). Recently, elastography has also shown promise as a complementary tool for identifying metastatic lymph nodes (26). Of these features, microcalcifications and cystic degeneration have been reported to have the highest specificity (up to 100%), whereas increased peripheral vascularity has the highest combined sensitivity and specificity (86% and 82%) (Figs 7, 8) (27). Notably, there is no size cutoff that is adequately sensitive or specific for malignancy. Therefore, nonenlarged lymph nodes with these suspicious features should be treated as metastases until proven otherwise. Nonenlarged morphologically normal lymph nodes do not need to be mentioned individually in the report, particularly if there is a normal fatty hilum, which virtually excludes malignancy (sensitivity, 100%; specificity, 29%) (27). However, evaluation of the cervical lymph nodes should always be specifically documented, even when they manifest as normal.

Residual metastatic lymph nodes are the most common source of persistent or recurrent disease, which may reflect incomplete preoperative imaging. Suspicious lymph nodes in the central compartment are the most common and must be reported because they warrant a therapeutic central compartment lymph node dissection. Otherwise the central compartment lymph node may not be addressed intraoperatively, which can



Figures 6–8. **(6)** Metastatic left level III cervical lymph node in a 42-year-old woman with left papillary thyroid cancer confirmed at FNA. **(a)** Gray-scale US image shows an enlarged, rounded, left level III lymph node with an abnormally thickened, irregular, heterogeneous hilum. The lymph node is lateral to the common carotid artery (black arrow) and internal jugular vein (white arrow), indicating that it is in the lateral compartment. **(b)** Color Doppler US image demonstrates increased peripheral vascularity (arrowhead) of the metastatic level III lymph node. **(7)** Right papillary thyroid cancer in a 44-year-old woman with a biopsy-proven metastatic right level IV cervical lymph node. **(a)** Gray-scale US image shows an enlarged rounded lymph node with microcalcifications (arrowhead) and loss of the fatty hilum. **(b)** Color Doppler US image of the same lymph node demonstrates hypervascularity (arrowheads). **(8)** Left papillary thyroid cancer in a 51-year-old woman with a biopsy-proven metastatic left level IV cervical lymph node. Sagittal **(a)** and transverse **(b)** gray-scale US images show a rounded 1.0 × 0.8 × 0.7-cm left level IV cervical lymph node with cystic degeneration and loss (arrow) of its fatty hilum.

result in incomplete disease resection. Although some institutions perform prophylactic central compartment lymph node dissections, this is controversial and its value is unclear (11). Preoperative detection of a lateral compartment lymph node is even more critical, as the lateral compartment will only be exposed intraoperatively if disease is suspected. However, if US depicts suspicious lateral compartment lymph nodes, these should be confirmed at FNA. A positive FNA report for metastasis will lead to both central and lateral compartment dissections (11).



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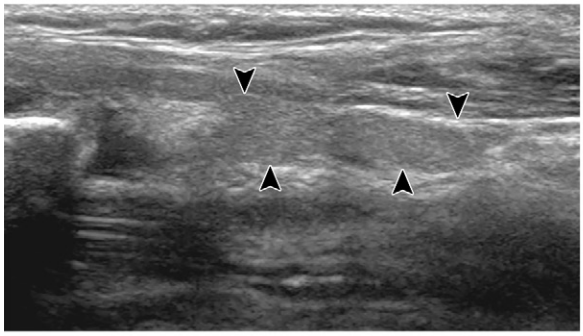


b.

Figure 9. Remnant thyroid tissue in a 36-year-old woman after thyroidectomy for medullary thyroid cancer that was confirmed at FNA. **(a, b)** Transverse **(a)** and longitudinal **(b)** gray-scale US images demonstrate an isoechoic ovoid structure (arrowheads) in the left thyroid bed. **(c)** Axial contrast-enhanced CT image demonstrates that the structure (arrow) enhances as expected for thyroid tissue. Arrowhead = left carotid artery, ∗ = left internal jugular vein, ☆ = trachea.

In spite of this, failing to evaluate and/or comment on cervical lymph nodes has been frequently cited as a deficiency in radiologist-performed thyroid US (7). For example, in a series reported by Carneiro-Pla and Amin (6), radiologist-performed US did not report enlarged central compartment lymph nodes in 17 of 20 patients (85%) and missed enlarged lateral compartment lymph nodes in 11 of 12 patients (92%). Furthermore, the radiology department's US report failed to mention cervical lymph node status in 85 of 115 patients (74%). In another retrospective analysis of 334 patients, radiologists missed enlarged or suspicious cervical lymph nodes in 13 patients, which were subsequently detected and sampled at surgeon-performed US (5).

Comprehensively evaluating the cervical lymph nodes is a mandatory component of US for patients with known or suspected thyroid cancer (including those with a suspicious nodule), as cervical lymph node status determines the type of surgery performed and affects prognosis.

Postoperative Neck US

Recurrent or residual disease after thyroidectomy occurs most frequently in the cervical and mediastinal lymph nodes (74%), thyroid bed (20%), and trachea or adjacent muscles (6%) (28,29). Given that most of these lesions are nonpalpable subcentimeter lesions, US is crucial as it is often the sole means of postoperative surveillance and detection (30–32).

The thyroid bed can be particularly challenging to evaluate, as small (<11 mm) nodules occur in up to one-third of patients, but most of these small nodules (>90%) are not malignant and do not progress over time (29). For this reason, the 2013 European Thyroid Association guidelines for postoperative US management suggest waiting 3 months postoperatively before imaging the surgical bed to allow for resolution of postoperative changes (25). Normally the postoperative thyroid bed typically consists of fibrofatty proliferative tissue, which appears as an inverted triangular echogenic area at US. In the absence of thyroiditis or radioiodine therapy, residual unresected thyroid tissue will have an US appearance similar to that of normal thyroid tissue preoperatively (Fig 9). In contrast, residual or recurrent thyroid cancer may manifest as a hypoechoic nodule, although similar sonographic findings can be seen with autoimmune thyroiditis, a postoperative granuloma or neuroma, a reactive lymph node, or a parathyroid adenoma (25). Residual thyroid tissue in a patient who has been treated with radioiodine therapy will appear hypoechoic and heterogeneous, which can be a potential pitfall and mimic a suspicious nodule.

US features that favor malignancy in thyroid bed nodules are similar to those used to predict malignancy in de novo thyroid nodules. These include taller-than-wide shape, irregular margins, increased vascularity, microcalcifications, and cystic components (Fig 10) (33).

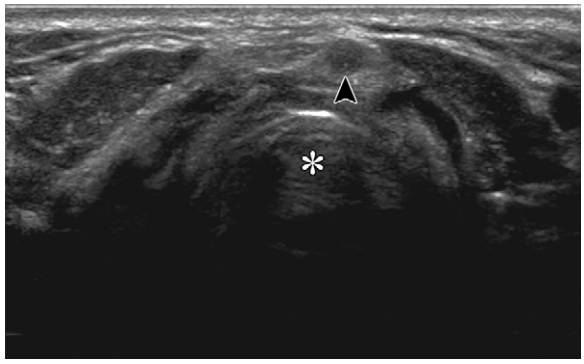
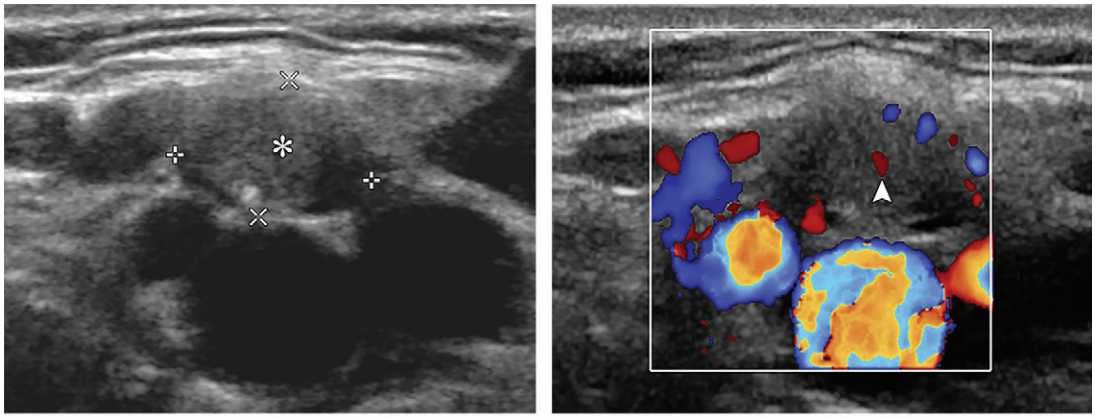


Figure 10. Locally recurrent papillary thyroid cancer in a 51-year-old man with persistently positive thyroglobulin levels after thyroidectomy for papillary thyroid cancer. Gray-scale US image shows a 0.3-cm nodule (arrowhead) in the medial left thyroid bed anterior to the trachea (*). The nodule is hypoechoic, is taller than wide, and has ill-defined margins. It was sampled at FNA and was confirmed to be a local recurrence of cancer.



a. **b.**

Figure 11. Recurrent metastatic left level II cervical lymph node that was confirmed at FNA in a 42-year-old woman with a history of left papillary thyroid cancer who had been treated with thyroidectomy. **(a)** Transverse gray-scale US image shows a left level II cervical lymph node (*) that is enlarged, is rounded in morphology, and has lost its fatty hilum. **(b)** Color Doppler US image of the node demonstrates increased peripheral and central vascularity (arrowhead).

Regional lymph nodes (levels II–VI) must also be carefully scrutinized postoperatively, as they are the most likely site of recurrent disease in patients with rising serum thyroglobulin levels (29). Although lymph node sizes greater than 0.8 cm along the short axis in level II or greater than 0.5 cm along the short axis in levels III–VI are used as cutoffs, size is not sensitive or specific for malignancy, and suspicious sonographic features must be considered, similar to preoperative assessment (Fig 11). Ultimately, regardless of size, suspicious cervical lymph nodes may require FNA or core biopsy.

If recurrent disease is detected, it should be clearly denoted as within either the central neck (either thyroid bed or central compartment lymph node) or the lateral neck to guide management (29). Depending on patient and primary tumor factors, these patients may undergo biopsy with repeat surgery and/or active surveillance.

Serum thyroglobulin levels can be a useful correlate with the imaging findings when assessing the patient for disease recurrence. The ATA recommends serum thyroglobulin level measurements every 6–12 months after treatment for thyroid cancer, with more frequent measurements for high-risk patients. In patients receiving thyroid hormone replacement therapy, a thyroglobulin level of 0.2–0.3 ng/mL has the best accuracy for detecting persistent disease (11). However, after a hemithyroidectomy, cervical US is the mainstay for surveillance as the serum thyroglobulin level will be of limited value (25).

Optimal Thyroid US Reporting

It is critical for radiologists to recognize the necessary components of a comprehensive thyroid US report to ensure optimal patient care, avoid dissatisfaction among referring endocrinologists and thyroid surgeons, and address the deficiencies that have been reported in the literature. Ideally, standardized templates should be used for these reports to ensure that all pertinent positive and negative findings are included (Fig 12). Use of a standardized report template will ensure that all fields are addressed and all key findings commented on, especially if there are multiple sonographers and radiologists caring for patients with thyroid cancer. Use of a standardized template also encourages a consistent sonographic technique, adequate imaging for all patients, and comprehensive assessment of all relevant findings by the radiologist (34).

Thyroid gland:

Right lobe: [ ] × [ ] × [ ] cm
Echogenicity: [normal, increased, decreased, heterogeneous]
Nodules: [present, absent]
Nodule [1]: [ ] × [ ] × [ ] cm
Location: [medial/lateral, superior/inferior]
Sonographic features: [cystic, spongiform, cystic solid, solid];
Echogenicity: [hyperechoic, hypoechoic, heterogeneous]
Microcalcifications: [present, absent]
Margins: [well-circumscribed, ill-defined, extracapsular extension, invasive, inferior pole not seen]
Internal vascularity: [present, absent]

Left Lobe: [ ] × [ ] × [ ] cm
Echogenicity: [normal, increased, decreased, heterogeneous]
Nodules: [present, absent]
Nodule [1]: [ ] × [ ] × [ ] cm
Location: [medial/lateral, superior/inferior]
Sonographic features: [cystic, spongiform, cystic solid, solid];
Echogenicity: [hyperechoic, hypoechoic, heterogeneous]
Microcalcifications: [present, absent]
Margins: [well-circumscribed, ill-defined, extracapsular extension, invasive, inferior pole not seen]
Internal vascularity: [present, absent]

Isthmus: [ ] cm
Echogenicity: [normal, increased, decreased, heterogeneous]
Nodules: [present, absent]
Nodule [1]: [ ] × [ ] × [ ] cm
Location: [medial/lateral, superior/inferior]
Sonographic features: [cystic, spongiform, cystic solid, solid];
Echogenicity: [hyperechoic, hypoechoic, heterogeneous]
Microcalcifications: [present, absent]
Margins: [well-circumscribed, ill-defined, extracapsular extension, invasive, inferior pole not seen]
Internal vascularity: [present, absent]

Cervical lymph nodes:

Abnormal lateral cervical lymph nodes: [present, absent]
Lymph node [1]: Cervical level [2, 3, 4, 5]; [ ] × [ ] × [ ] cm
Location: [medial, lateral] to common carotid artery
Sonographic features: [cystic, microcalcifications, loss of fatty hilum, peripheral vascularity];
Echogenicity: [hyperechoic, hypoechoic, rounded]

Abnormal central cervical lymph node: [present, absent]
Lymph node [1]: Cervical level [6]; [ ] × [ ] × [ ] cm
Location: [medial, lateral] to common carotid artery
Sonographic features: [cystic, microcalcifications, loss of fatty hilum, peripheral vascularity];
Echogenicity: [hyperechoic, hypoechoic, rounded]

Figure 12. Sample reporting template for preoperative thyroid US.

Specifically, preoperative neck US reports should include the size (in three dimensions), number, location, and description of all suspicious thyroid nodules (echogenicity, composition, margins, presence and type of calcifications, whether taller than wide, and vascularity), including contralateral nodules (11). Suspicious nodules located posteromedially near the recurrent laryngeal nerve should be highlighted because their presence may influence patient counseling and surgical strategy (3).

Suspicious nodules should also be carefully scrutinized for features that suggest extrathyroidal extension or invasion of local structures. The inferior margins of both thyroid lobes must be clearly visualized and documented; otherwise, retrosternal extension must be suggested.

Cervical lymph node levels I–VI must be evaluated and documented bilaterally. If present, enlarged or sonographically abnormal cervical lymph nodes must be described and localized, with particular attention to anatomic landmarks that can be used during FNA or neck dissection. The absence of suspicious lymph nodes must also be documented.

For localization of suspicious thyroid nodules or cervical lymph nodes, it may be helpful to use line diagrams to ensure that the correct nodule(s) or lymph nodes are sampled or resected, particularly when there are multiple bilateral findings (25). The exact anatomic location may be difficult to convey within the text of the report and may be better depicted visually on a diagram (Fig 13d). Because biopsy or FNA is often performed by a different radiologist from the one interpreting the US images, such visual representations can help ensure consistency and minimize confusion. Utilizing Cartesian coordinates with measurements relative to anatomic structures (eg, the mandible, midline, or sternal notch) may also be helpful, either in the report or as part of the line diagram. In addition to aiding localization during surgery or FNA, line diagrams and coordinates may also be helpful in ensuring correlation during follow-up scans (25). If used, line diagrams

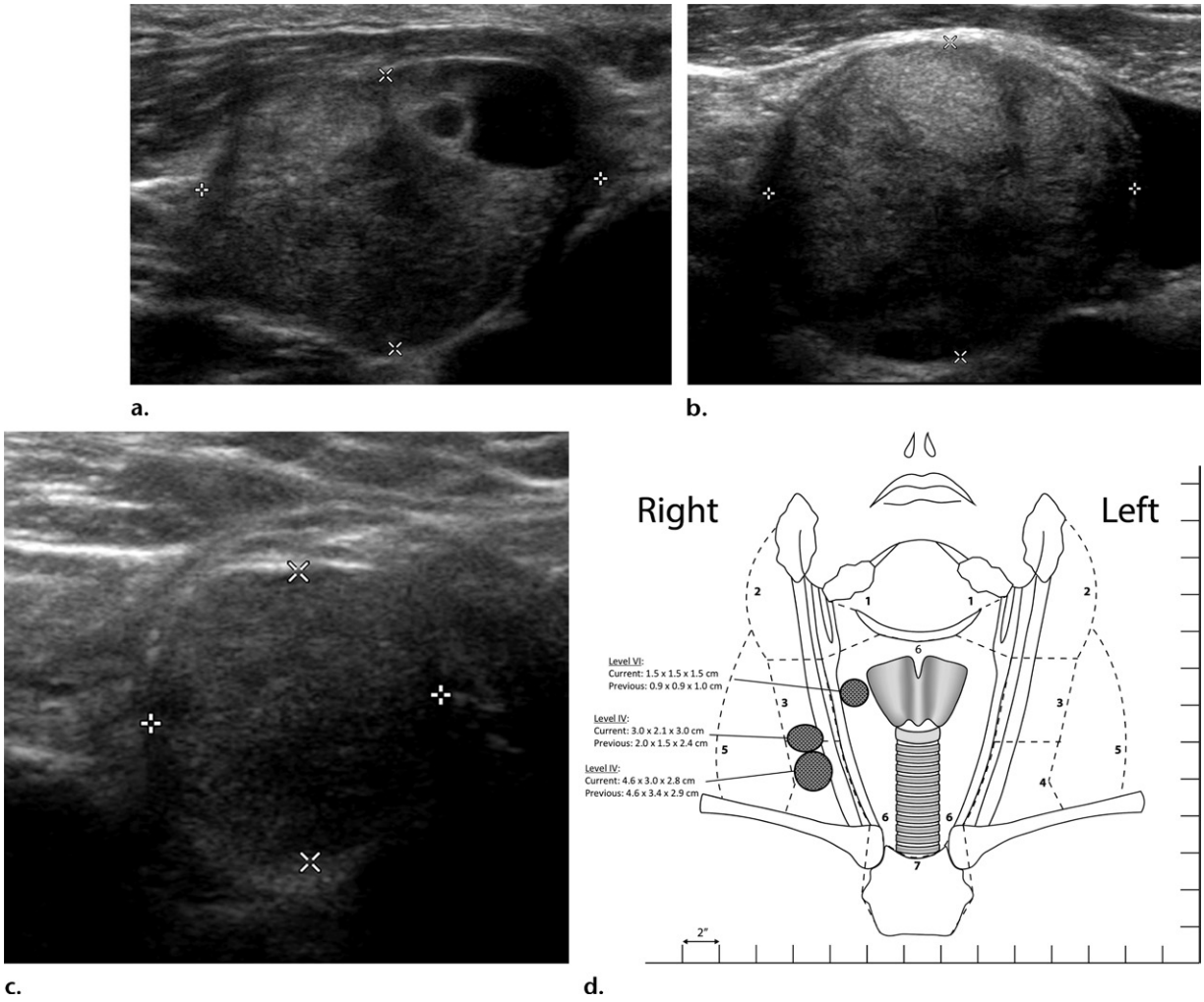


Figure 13. Papillary thyroid cancer in a 57-year-old man with rising thyroglobulin levels. **(a–c)** US images show recurrent metastatic right cervical lymph nodes in the lateral **(a, b)** and central **(c)** compartments. **(d)** The locations and sizes of the abnormal lymph nodes are mapped on a diagram and used to plan subsequent biopsy and/or neck dissection. The diagram can be scanned and uploaded into the hospital picture archiving and communication system (PACS) or the patient's electronic medical record, where it can be viewed by the surgeon for surgical planning or by the interventionalist for biopsy planning.

should be scanned and uploaded into the hospital PACS or the patient's medical record so that they are viewable by all of the patient's physicians.

Conclusion

Radiologists play a central role in preoperative staging for patients with DTC. Complete surgical resection is the most important factor in satisfactory patient outcome and requires adequate preoperative imaging to document all sites of disease. However, surgeon-performed US is increasing because of inadequate or incomplete imaging performed by radiologists. Radiologists must provide a thorough, comprehensive, clinically appropriate neck US report to guide treatment and ensure optimized patient care.

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