CHAPTER 5
Pediatric Ultrasound of the Neck

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INTRODUCTION

The spectrum of imaging abnormalities encountered during pediatric neck ultrasound extends well beyond the thyroid gland—both anatomically and conceptually—to include normal anatomic variants and embryologically derived pathologies that are less commonly seen in older patients. This chapter will briefly discuss an approach to scanning children's necks and then focus on the spectrum of abnormalities that may be encountered during pediatric neck ultrasound, first addressing embryologically derived pathology, normal variants, and non-thyroidal cervical abnormalities, before focusing on the appearance of specific diseases that involve the thyroid itself.

PATIENT PREPARATION

The key to successful pediatric neck ultrasound lies in appropriate patient preparation. For a very young child, the procedure can be frightening: A trip to the doctor in and of itself is scary, but then you are forced to lie on your back while a stranger in a white coat smears cold goo all over your neck and someone else holds you down, forcing you to stay still while your parents sit nervously on the side. Without proper planning, such an endeavor is difficult at best and an utter failure at worst. Understanding the child's perspective helps one prepare better for this examination and thus allows better diagnostic imaging.

Ideally, as with all pediatric medical care, an ultrasound should be performed in an environment that is welcoming and nonthreatening to children. Age-appropriate toys and, if available, Child Life

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Specialists, should be at hand to comfort the child. Newborns are especially soothed by ceiling projectors and warming pads on the scanning bed. Transducer gel warmers should be used to make the gel a comfortable temperature and, if appropriate, the child should be offered a chance to feel the gel and transducer prior to the examination. If not actually performing the study, the interpreting physician should be closely involved in image acquisition so as to decrease the time that the child needs to stay still.

Ultrasound performed by the physician is also helpful because many pediatric neck abnormalities extend into the lateral neck, where children's small size and the complex regional anatomy can become quite confusing and real-time scanning helps to better conceptualize any complex transspatial lesions. In addition to being skilled and experienced with imaging pediatric neck lesions, the interpreting physician should be knowledgeable as to when computed tomography, magnetic resonance imaging, or scintigraphy would better elucidate a given abnormality; they should also be facile in correlating any ultrasound abnormalities with findings made visible by other modalities. For these reasons, at our institution, all pediatric ultrasound is performed or directly supervised by subspecialty-trained pediatric radiologists.

Finally, it is crucial to use a high-resolution, high-frequency (at least 15 MHz), linear-array transducer to best visualized the pediatric thyroid gland and cervical soft tissues. Unfortunately, traditional high-resolution transducers offered with most ultrasound packages are often too large to comfortably use on the very short necks of neonates and young infants. Likewise, infants and toddlers often have quite chubby chins and necks and, because the thyroid lies relatively higher in the neck at this age, the transducer may not be able to obtain close contact with the skin. In these young children, the thyroid gland may be best imaged by a specialized small footprint probe, such as those used in neonatal echoencephalography; of course, the sonographer should be familiar with and experienced at using such probes.

EMBRYOLOGICALLY DERIVED PATHOLOGY

Embryology of the Thyroid Gland

The thyroid gland originates at the base of the tongue in an embryological structure known as the foramen cecum and then descends into the lower neck by way of the thyroglossal duct. As the developing gland descends into the lower neck, it divides into separate lobes connected to each other by an isthmus.

After the thyroid gland reaches its final location—inferior to the hyoid bone and anterior to the trachea—the thyroglossal duct involutes. Aberrations of this normal development result in various forms of thyroid dysgenesis or thyroglossal duct remnants that one may encounter during pediatric neck ultrasound.

Congenital Hypothyroidism

Congenital hypothyroidism (CH) is relatively common, occurring in approximately 1 per 3,000 births. It is classified as either transient or permanent; the transient form accounts for 20% of newborns with CH and occurs as a result of maternal iodine deficiency or secondary to in utero exposure to antithyroid drugs, maternal TSH-receptor antibodies, or very high levels of iodine. Permanent CH results from dyshormonogenesis, autoimmune disease in the newborn, or from thyroid dysgenesis (aplasia, hypoplasia, or ectopy).

CH is the most easily treated form of developmental delay and ultrasound is clinically useful to help differentiate its many causes. In patients with transient CH or with CH due to dyshormonogenesis or autoimmune thyroiditis, ultrasound will demonstrate an orthotopic thyroid gland; the gland may be normal sized in transient CH or enlarged in cases of dyshormonogenesis (Fig. 5.1) or autoimmune disease. If CH is secondary to thyroid dysgenesis then ultrasound will demonstrate an absent or small thyroid gland.

Thyroid Aplasia

Thyroid aplasia presents with CH and an absence of any thyroidal tissue. The defect is usually sporadic, but there are some familial forms and both autosomal dominant and autosomal recessive inheritance patterns have been reported. Neck ultrasound fails to reveal any thyroid tissue in the thyroid bed and no uptake is seen with I-123 scintigraphy.

Thyroid Hypoplasia

Ultrasound in children with CH may sometimes demonstrate a small, but otherwise normal-appearing thyroid gland (Fig. 5.2). This is particularly common in those children who have CH and trisomy 21 (children with trisomy 21 are also more likely to have small benign thyroid cyst) (Fig. 5.3). There are published charts of normal thyroid volumes for different populations and these should be used to evaluate the size of the thyroid in children with hypothyroidism, congenital or otherwise.

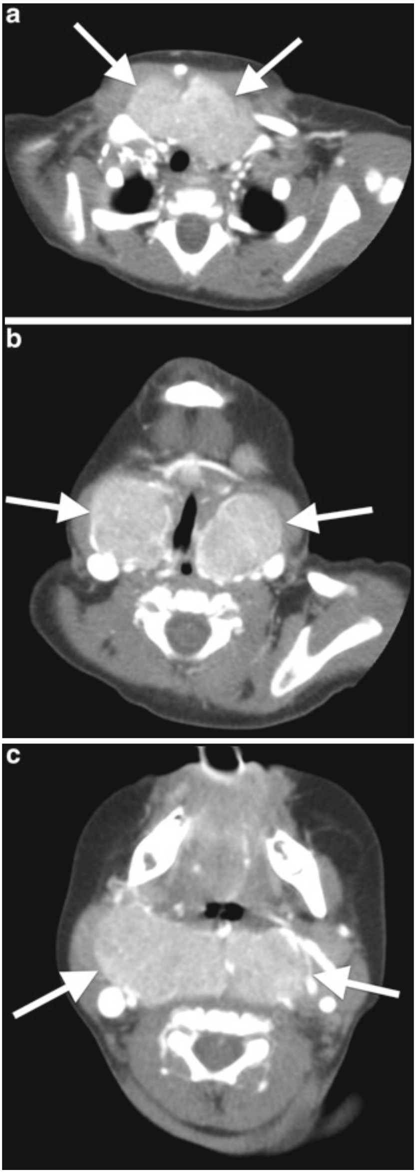

FIG. 5.1. Goitrous thyroid in congenital hypothyroidism. Axial CT images (**a**, **b**, **c**) show a massively enlarged thyroid (*arrows*) in a 5-month-old with a TSH over 300. Full ultrasonic visualization of the thyroid gland is difficult in young children because of the overall short length of their necks

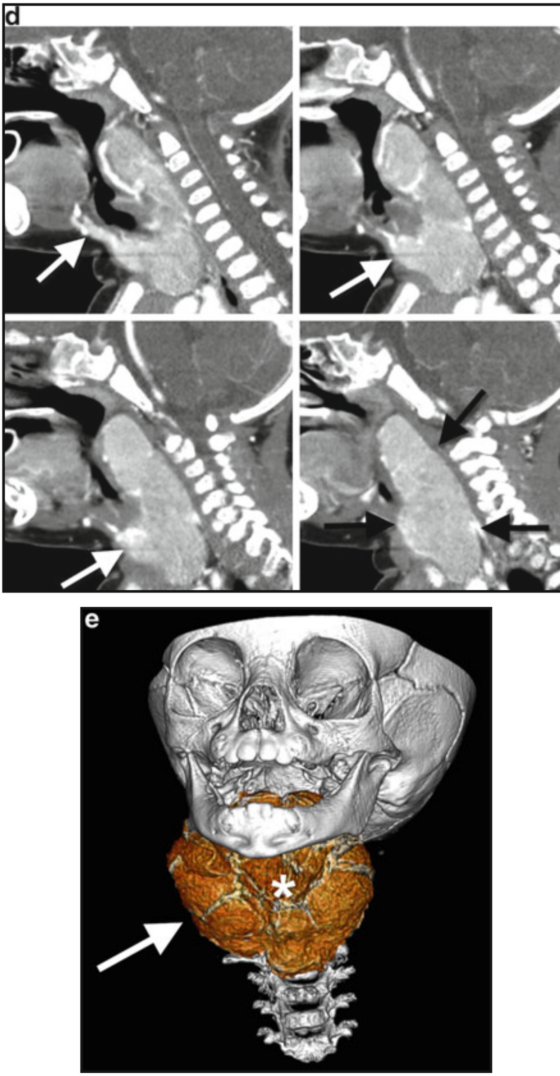

FIG. 5.1. (continued) compared to the size of most high-frequency transducers and because of the relatively high positioning of the thyroid gland in the neck compared to adults. This is best appreciated on sagittal CT images from the same patient, which well demonstrates the patient's short neck and how the path of least resistance for the thyroid to enlarge is posterior (*arrows*, **d**). On a 3D CT reconstruction (**e**), note how the thyroid gland (*arrow*) wraps around the airway (*asterisk*).

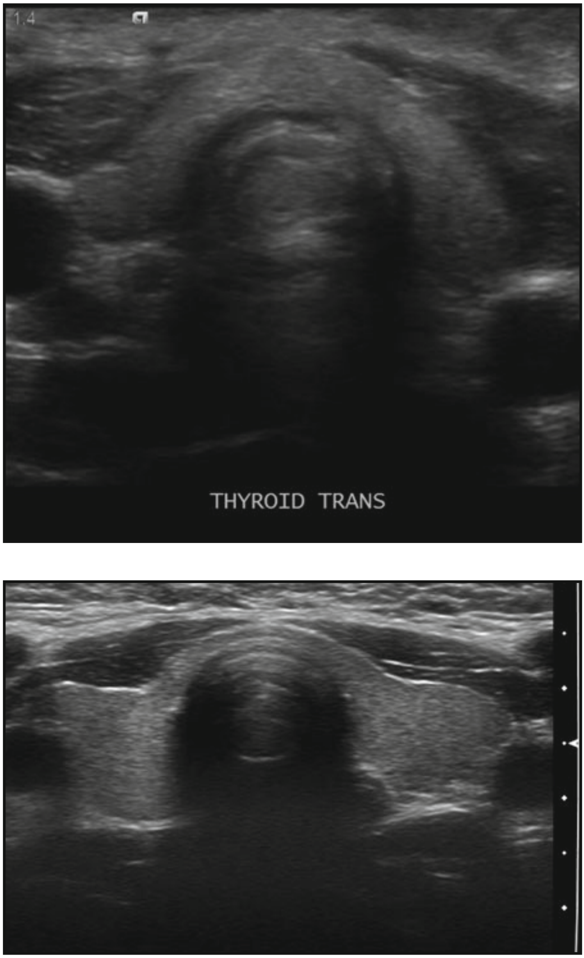

FIG. 5.2. Thyroid hypoplasia. In thyroid hypoplasia, the gland is small and difficult to visualize; the right and left lobes may both be small and the isthmus may be relatively normal thickness, as shown in a patient with congenital hypothyroidism and trisomy 21 (**a**). Compare this to the thyroid of a normal child (**b**), which is well-defined, normal volume, and well-proportioned.

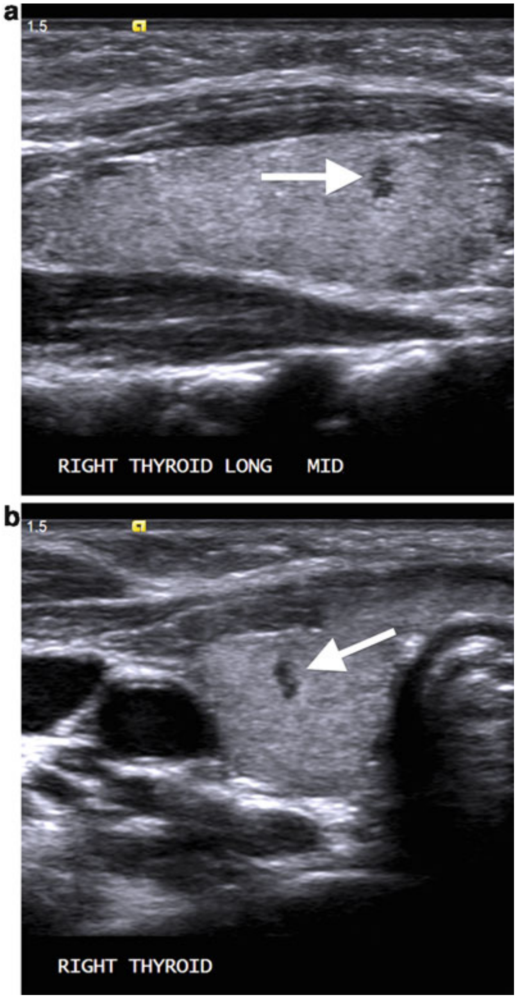

FIG. 5.3. Benign thyroid cyst in trisomy 21. Longitudinal (**a**) and transverse (**b**) ultrasound images in a 26-month-old boy with trisomy 21 shows the typical appearance of a very small hypoechoic cyst (*arrows*) seen in patients with Down syndrome. Note lack of significant posterior acoustic enhancement because these cysts are so small.

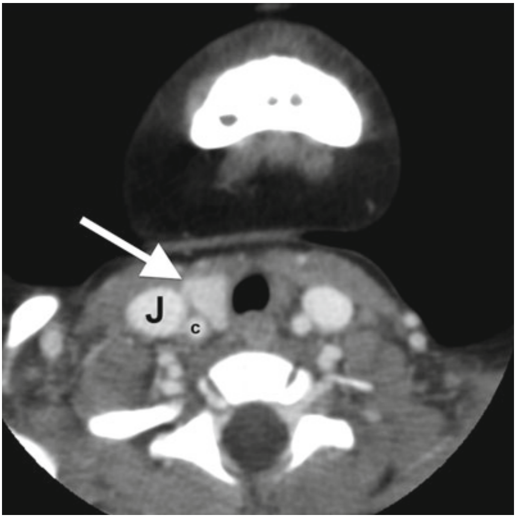

FIG. 5.4. Left thyroid hemiagenesis. Axial CT image in a 26-month-old with a retropharyngeal abscess shows absence of the left lobe of the thyroid gland. The right lobe is shown with an arrow, and the right jugular vein (*J*) and carotid artery (*c*) are also annotated. Although not present in this child, patients with an absent left thyroid lobe usually have a small, but blunted isthmus.

Thyroid Hemiagenesis

Thyroid hemiagenesis is a rare congenital anomaly in which one lobe of the thyroid fails to form. It is the most innocuous form of thyroid dysgenesis and is much more common in girls. In hemiagenesis it is almost always the left lobe that is absent; the right lobe has a normal size and appearance and, although blunted, the isthmus is usually present (Fig. 5.4). For unknown reasons, the isthmus will be absent in rare cases of right hemiagenesis (Fig. 5.5). Although hemiagenesis is considered an incidental finding, numerous studies have shown that these patients have a slightly increased rate of all forms of thyroid pathology, from hyperthyroidism to carcinoma. The diagnosis of thyroid hemiagenesis should be clearly communicated to the surgeon in patients who are to undergo any type of neck surgery.

Ectopic Thyroid

Ectopic, or aberrant, thyroid tissue can be found anywhere along the normal path of thyroid descent, but is most commonly found at the base of the tongue, in which case it may be referred

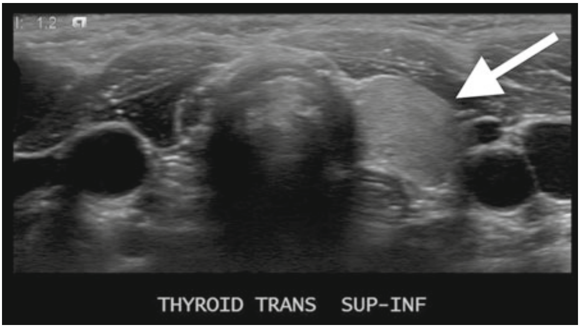

FIG. 5.5. Right thyroid hemiagenesis. A transverse image of the thyroid reveals a normal left lobe (arrow), but no right lobe or isthmus. Right thyroid hemiagenesis is quite rare.

to as a lingual thyroid (Fig. 5.6). Ultrasound of the thyroid bed may reveal a hypoplastic thyroid or no thyroid tissue at all. Further imaging workup varies according to local preferences and practice; although I-123 scintigraphy is very sensitive for the presence of ectopic thyroid tissue, it fails to localize exactly where along the path from the base of the tongue to the inferior neck any potential aberrant thyroid tissue exists. Contrast-enhanced CT is especially helpful for the evaluation of thyroid ectopia because of its excellent spatial resolution and ability to provide multiplanar images, which best identify smaller rests of ectopic thyroid tissue (Fig. 5.7) or any potential thyroglossal duct remnants.

Thyroglossal Duct Cysts

The thyroglossal duct is a normally transient structure that involutes during fetal life; if it fails to do so, any remnants may slowly collect fluid and eventually manifest as a cystic neck mass. Ninety percent of thyroglossal duct cysts (TGCs) present before age 10, and the typical history is a young child with a painless and compressible midline or paramidline mass. There is often a history of waxing and waning size, which occurs when there is irritation from recurrent upper respiratory tract infection or minor trauma. Sometimes TGCs become secondarily infected and present as an acutely painful, inflamed mass. If a TGC has not been complicated by prior infection or bleeding, then it appears as an anechoic cystic mass with increased through transmission and sharp,

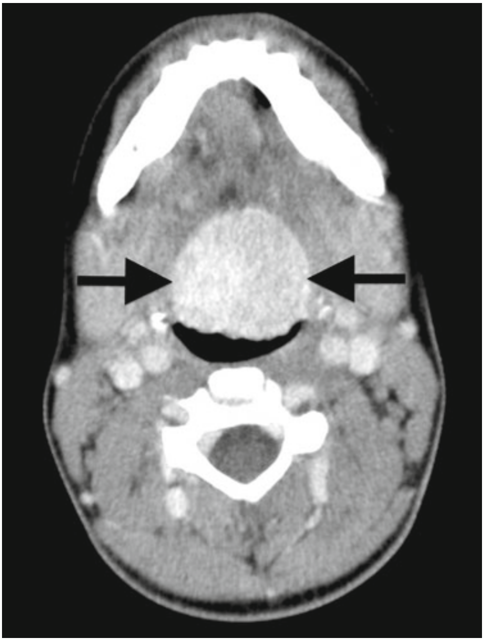

FIG. 5.6. Lingual thyroid. An axial enhanced CT scan through the neck in a young child with hypothyroidism, a long-standing sensation of neck fullness, and tongue mass on radiographs shows a clump of high attenuation thyroid tissue in the base of the tongue, known as a lingual thyroid.

well-defined margins. They are usually spherical but may have tubular configuration (Fig. 5.8). About half are found at the level of the hyoid bone, a quarter above it, and another quarter below it; they should never be found below the level of the thyroid. If complicated by prior hemorrhage or infection, TGCs may have more echogenic contents, small septations, and a thickened, irregular margin; they occasionally appear solid (although should still cause increased through transmission) (Fig. 5.9). Complete surgical resection is needed or TGCs will recur.

Fourth Branchial Apparatus Anomalies

Another embryologic anlage that may cause pediatric thyroid abnormalities is the fourth branchial apparatus. Fourth branchial apparatus anomalies (BAAs) include a spectrum of epithelial lined remnants that only involve the left lobe of the thyroid. Fourth

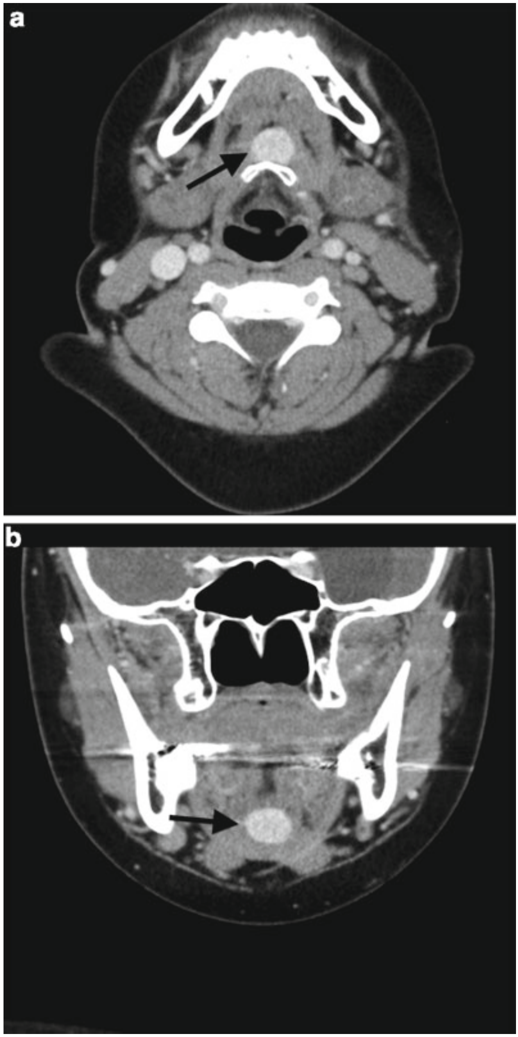

FIG. 5.7. Ectopic thyroid. Aberrant thyroid tissue may be found anywhere along the course of the thyroglossal duct, from the base of the tongue to the thyroid bed. Although scintigraphy is often espoused as the study of choice to identify ectopic thyroid tissue, it provides little spatial resolution. CT has the advantage of significantly better spatial resolution and the ability to provide multiplanar reconstructions, which can often better demonstrate rest of aberrant tissue, as shown in this patient with hypothyroidism, no thyroid tissue in the thyroid bed, and a small rest of aberrant thyroid (*arrows*) anterior to the hyoid bone.

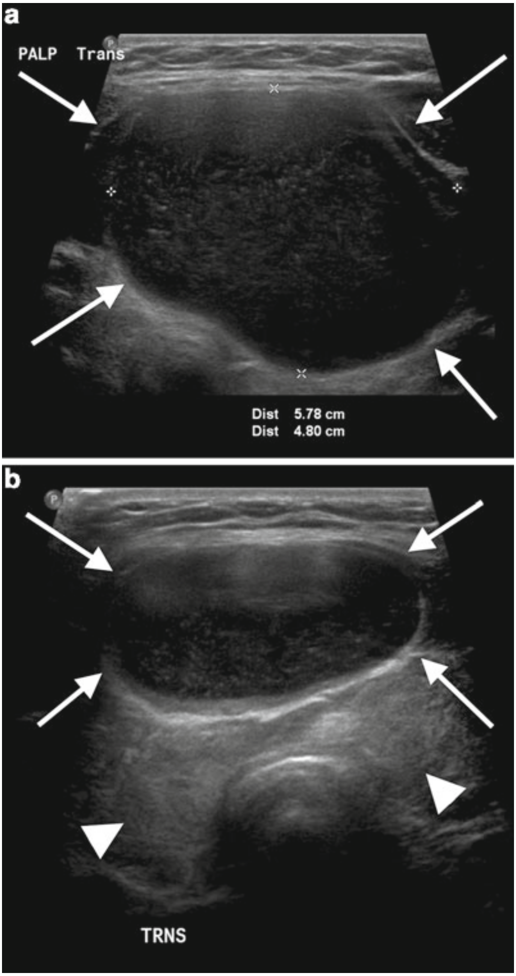

FIG. 5.8. Thyroglossal duct cyst. An US was obtained on this teenager to evaluate a long-standing palpable thyroid mass. The mass turned out to be a thyroglossal duct cyst. Transverse US images show a predominantly anechoic cyst with scattered low-level echos (*arrows*, **a** and **b**). This minimally complex thyroglossal duct cyst sits just above the level of the thyroid gland (*arrowheads*, **b**).

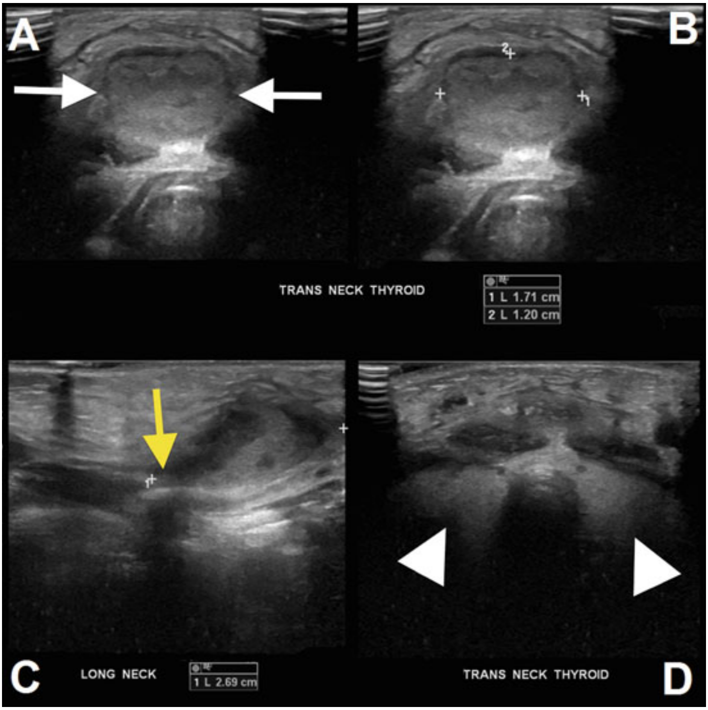

FIG. 5.9. Complex thyroglossal duct cyst. US was performed to evaluate a new painful thyroid mass in a 2-year-old boy. The images demonstrate that the mass is actually a heterogeneous, isoechoic cystic collection (*calipers and white arrows*) separate from the thyroid gland (*arrowheads*). This was an infected thyroglossal duct cyst; note its "tail" (*yellow arrow*) extending cephalad towards the tongue, reflecting this TDG's embryologic origins.

BAAs may become infected and cause suppurative thyroiditis, abscess, cystic mass, or sinus tract to the pyriform sinus; imaging depends on the specific patient's complication. Suppurative thyroiditis—which can be caused by a BAA or occur primarily—begins as a focal area of abnormally decreased echogenicity within the thyroid (Fig. 5.10). With worsening infection and abscess

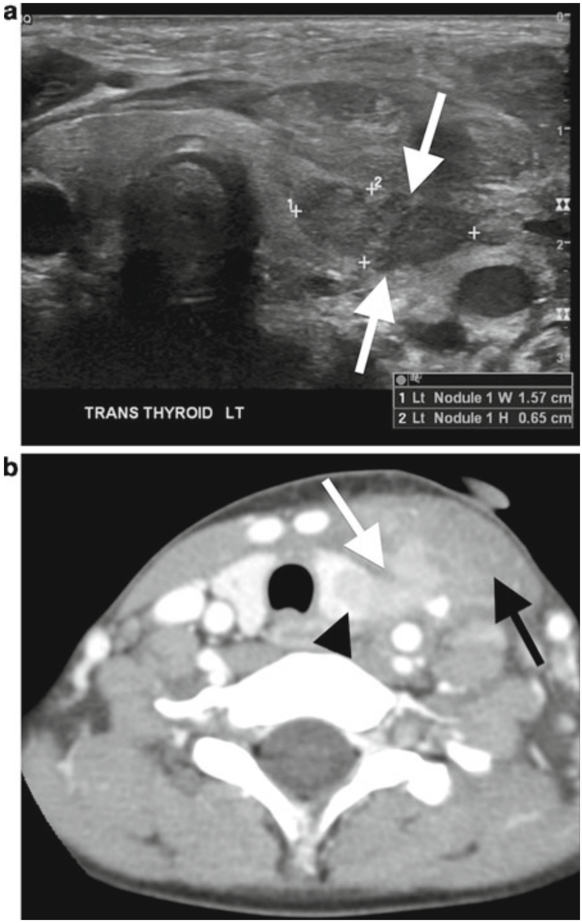

FIG. 5.10. Fourth branchial apparatus anomalies. Suppurative thyroiditis in a 6-year-old boy with fever and neck pain. Embryologic remnants from the fourth branchial apparatus are almost always left-sided and may lead to any one of several abnormalities, from suppurative thyroiditis to a sinus track to infected cysts or abscesses. In this child, transverse US shows a well-defined, focal, heterogeneously hypoechoic nodule (*calipers*, **a**) extending through the thyroid capsule (*arrows*, **a**). Axial CT in the same patient also shows the focal area of suppuration in the upper pole of the left lobe (*arrowhead*, **b**) as well as more detail of the extracapsular extension (*white arrow*, **b**) and inflammation of the overlying strap musculature (*black arrow*, **b**).

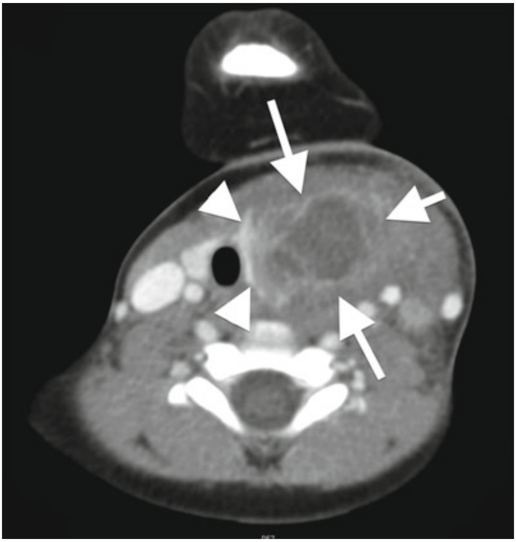

FIG. 5.11. Fourth branchial apparatus anomalies. An enhanced CT in a 13-year-old with fever, neck pain, and new thyroid mass shows a "claw" of thyroid tissue (*arrowheads*) around a large, complex, peripherally enhancing fluid collection emanating from the superior pole of the left thyroid lobe, typical for an infected fourth BAA cyst.

formation, a complex focal fluid collection may develop, usually with heterogeneous but hypoechoic internal contents; if caused by a BAA, a sinus tract may extend up into the deep neck towards the pyriform sinus. Such complications are best visualized by contrast-enhanced CT imaging (Fig. 5.11).

Inclusion Cysts

Small epidermal inclusion cysts are another common cause of palpable neck or "thyroid" masses in children. These cysts are characterized pathologically as either dermoids or epidermoids, both of which are benign congenital cysts derived from inclusion of ectodermic elements. On ultrasound, they appear as well-defined, avascular masses with internal echogenicity similar to the thyroid gland. The ultrasound findings of inclusion cysts are nonspecific (Fig. 5.12), but, because they contain dermal appendages, dermoids may have imaging characteristics identical to fat and therefore have a pathognomonic appearance on MRI and CT.

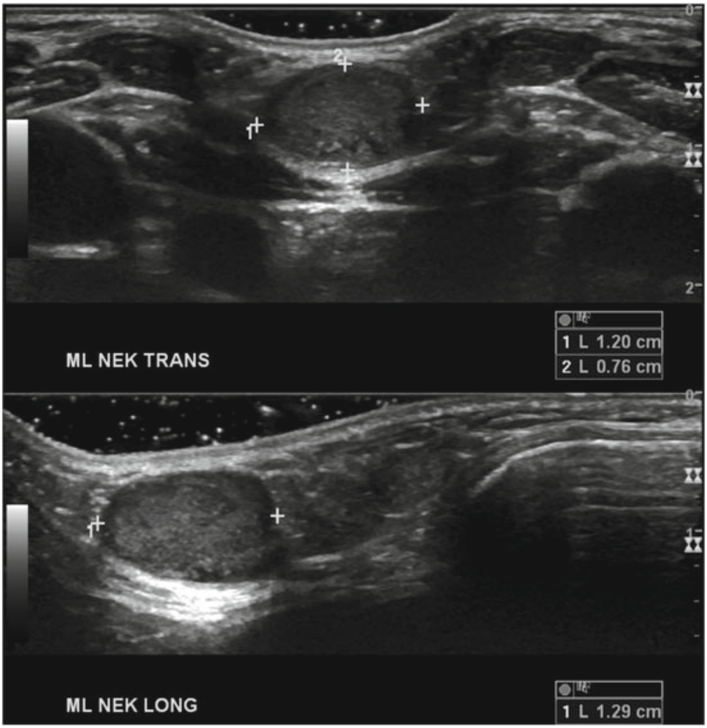

FIG. 5.12. Epidermal inclusion cyst. Transverse and longitudinal US images show a well-defined isoechoic nodule (*calipers*) in the subcutaneous soft tissues of the infrahyoid midline neck, just above the thyroid gland. Images are characteristic, but not diagnostic, of an epidermal inclusion cyst; tissue diagnosis is needed and in this case confirmed the diagnosis of dermoid.

Vascular Malformations

Vascular malformations are a common cause of pediatric neck masses. Broadly speaking, these lesions are a group of nonneoplastic congenital malformations caused by disordered development of vascular channels. They are categorized by the predominant channel involved and are therefore termed either lymphatic, venous, venolymphatic, or arteriovenous malformations. They may range from predominately solid to mostly cystic masses. Although they often infiltrate the thyroid gland, vascular malformations usually extend into the lateral neck.

Lymphatic malformations are usually transspatial, multicystic masses with numerous fluid–fluid levels (as a result of prior hemorrhage or infection) (Fig. 5.13). If predominately microcystic, lymphatic malformations may appear solid on ultrasound.

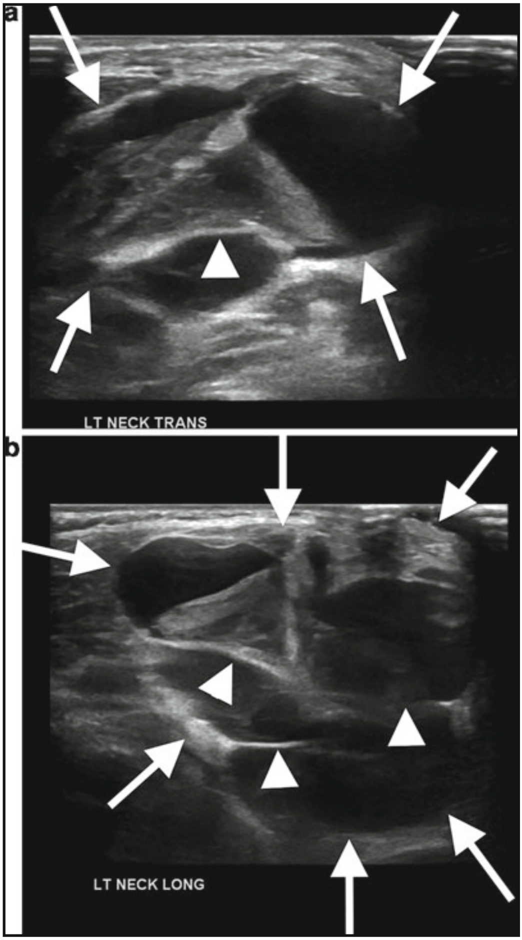

FIG. 5.13. Lymphatic malformation. Transverse (**a**) and longitudinal (**b**) neck ultrasound in a 3-year-old boy with new swelling near the thyroid gland reveals a very complex, transspatial, multiloculated fluid collection (*white arrows*, **a** and **b**) extending from the region of the thyroid (not shown) into the left lateral neck. Note the presence of thin septations (*arrowheads*, **a** and **b**), typical of macrocystic lymphatic malformations. Two axial fluid-sensitive sequence MR images (**c**) better show the internal characteristics of this complex cystic lesion (*yellow arrows*) as well as its relationship regional structures, including the thyroid gland (*small white arrows*, upper image). Again, note numerous thin septations (*arrowheads*) and fluid–fluid levels (*large white arrows*) from prior internal hemorrhage. Two contrast-enhanced MR images (**d**) show that the lesion (*yellow arrows*) does not enhance, supporting the diagnosis of lymphatic

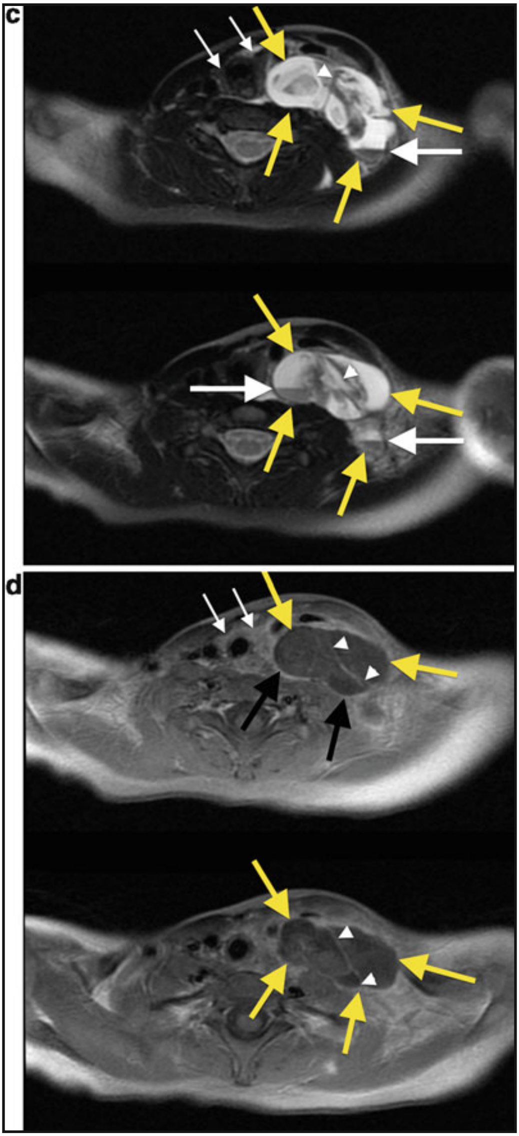

FIG. 5.13. (continued) malformation. The thin septations (*arrowheads*) are again well seen, as are regional soft tissues, including the thyroid gland (*small white arrows*, upper image).

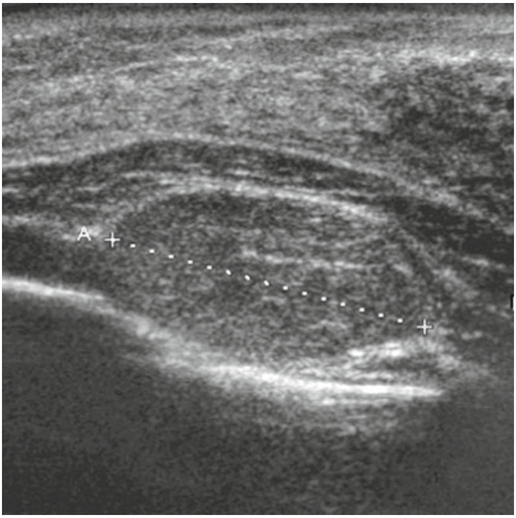

FIG. 5.14. Venous malformation. A longitudinal US image shows a well-defined, hypoechoic neck mass (*calipers*) in a 14-year-old girl. This appearance is nonspecific and excisional biopsy is mandatory to exclude a soft tissue sarcoma; biopsy in this case revealed a venous malformation.

Venous malformations generally appear as a lobulated, hyperechoic soft tissue mass that may contain phleboliths (which cause posterior acoustic shadowing) (Fig. 5.14). CT and MRI are very useful to demonstrate enhancement of the solid components of these lesions and are much better than ultrasound for delineating the entire extent of disease; these modalities usually help provide a confident diagnosis without biopsy.

Infantile Hemangioma

Unfortunately, the adult medical literature is littered with reports of masses related to the thyroid (and elsewhere in the body) that are inaccurately classified as a "hemangioma." These masses are in fact venous malformations and should be referred to as such. True infantile hemangiomas are benign neoplasms seen exclusively in young children. They also follow a very predictable natural history: they develop in early infancy, proliferate during the first year of life, and involute shortly thereafter. They may be seen near the thyroid gland but, unlike the aforementioned malformations,

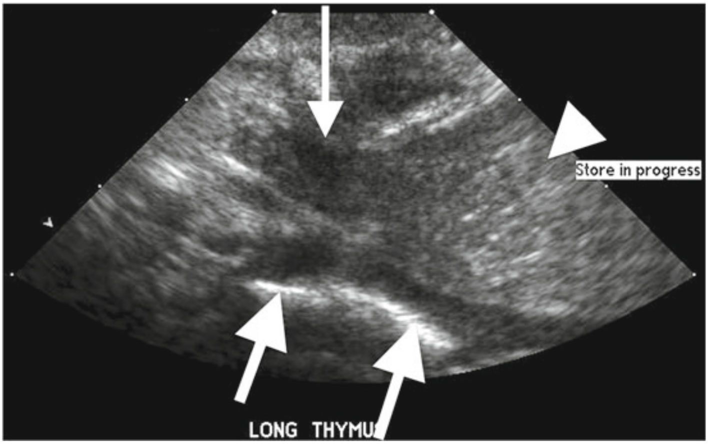

FIG. 5.15. Normal thymus tissue. The thymus may extend well into the neck in younger children and may be confounding when unexpectedly seen on ultrasound. Here a longitudinal US image shows a finger of thymic tissue extending in the neck (*small arrow*), just lateral to the thyroid gland and next to the carotid artery (*large arrows*). Note the normal appearance of the remainder of the thymus (*arrowhead*), which has a similar echotexture as the liver.

infantile hemangiomas are never seen in older children and adults. Infantile hemangiomas should not be confused with other lesions and are treated conservatively.

Thymic Tissue

The thymus is also derived from the branchial apparatus and, like the thyroid, descends into the neck early during fetal life. The two lobes of the thymus course behind the thyroid and sternocleidomastoid muscles and fuse at the level of the aortic arch, but occasionally a portion of the thymus will extend into the upper neck and may be visible on thyroid ultrasound. Knowledge of its normal appearance helps avoid any diagnostic dilemma. In younger children, the thymus is hypoechoic with an echotexture similar to that of the liver (Fig. 5.15). As children grow, the thymus becomes infiltrated with fat, which accentuates its internal septations and gives it a pattern sometimes referred to as a “starry sky” appearance. The thymus gland should never cause mass effect or displacement of vessels or other structures. On real-time imaging, the thymus gently pulsates with cardiac motion.

DIFFUSE THYROID DISEASES

Hashimoto thyroiditis is by far the most common diffuse thyroid abnormality seen in children. Early changes almost always involve the posterior portion of the gland, first manifesting as subtle coarsening of the normally smooth, homogeneous echotexture in the deeper part of the gland. As thyroiditis progresses, the posterior portion of the gland will develop very small (1–2 mm) round or oval areas of hypoechogencity. Eventually these subtle sonographic abnormalities progress to involve the entire gland and over several years (or with particularly pernicious disease, even sooner), the entire thyroid becomes increasingly heterogeneous (Fig. 5.16). Although these abnormalities are almost always present in children with Hashimoto thyroiditis, these sonographic features may at first be quite subtle and therefore it is important to use a high-resolution transducer to achieve adequate image resolution.

With chronic Hashimoto disease, the thyroid develops course, thickened septa that appear on ultrasound as branching, echogenic reticulations that form conspicuous rounded or oval foci of relatively hypoechoic thyroid tissue, small lesions known as pseudonodules (Fig. 5.17). It is this pattern of coarse reticular echoes and pseudonodules that becomes the dominant ultrasound feature in children with severe or chronic thyroiditis (Fig. 5.18).

Severe thyroiditis—especially early on—may cause diffuse enlargement of the gland, sometimes accompanied by marked hyperemia visible with power Doppler (Fig. 5.19). These changes are generally not, but may be, encountered in chronic disease. Also, unlike the early grayscale findings described earlier, increased Doppler flow seen in Hashimoto thyroiditis is often inhomogeneous and has no predictable pattern, sometimes sparing large swaths of the gland (Fig. 5.20).

One should not expect thyroid ultrasound to offer specificity with regard to other diffuse thyroid diseases; there are no imaging features that accurately suggest alternative diagnoses such as Graves' disease or nodular hyperplasia (both of which are far less common than Hashimoto thyroiditis in children) (Fig. 5.21). The clinical usefulness of ultrasound in the evaluation of children with Hashimoto thyroiditis lies in the identification of the very early grayscale abnormalities described earlier. In children, these subtle findings can suggest the diagnosis well before thyroid antibodies become positive.

Other important ultrasonic findings to be cognizant of in children with thyroiditis are the potential of associated lymphoma (which may cause regional lymphadenopathy) or the presence of a dominant nodule (which may represent a superimposed adenoma or thyroid malignancy).

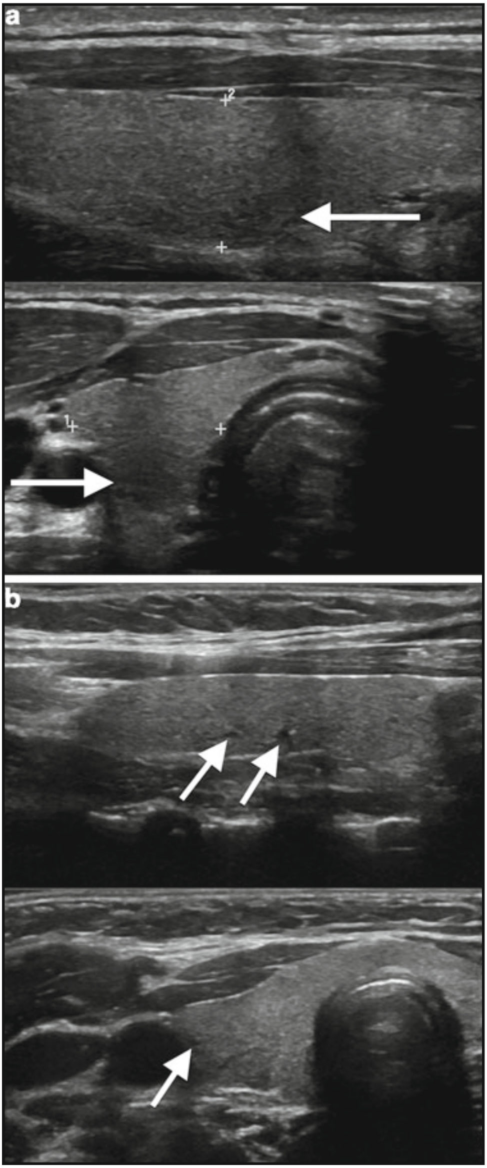

FIG. 5.16. Ultrasound findings in five children with thyroiditis of increasing severity. (a) 17-year-old boy: There is subtle coarsening of the thyroid echotexture in the posterior portion of the gland (*arrows*). (**b**) 13-year-old boy: In addition to mild coarsening, there are a few oval hypoechoic foci (*arrows*) in the posterior portion of the gland. (**c**) 12-year-old boy: The posterior gland has become progressively more heterogeneous (*arrows*), losing the smooth echotexture that characterizes the normal thyroid. (**d**) 7-year-old girl: Numerous thin, echogenic septations (*arrowheads*) have become visible

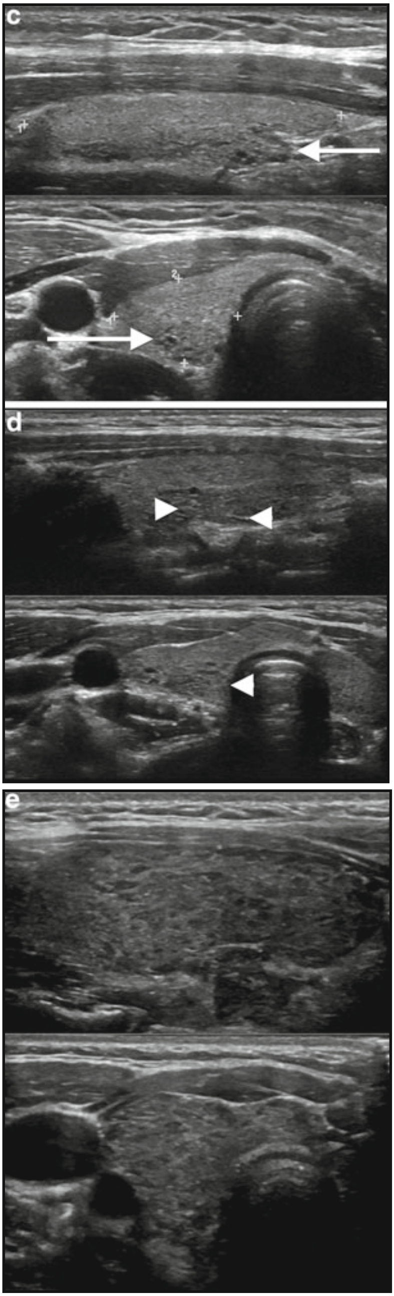

FIG. 5.16. (continued) within the area of coarse echogenicity. (**e**) 13-year-old girl: The whole gland now has a coarse, heterogeneous echotexture with thin septations and innumerable small hypoechoic foci visible throughout.

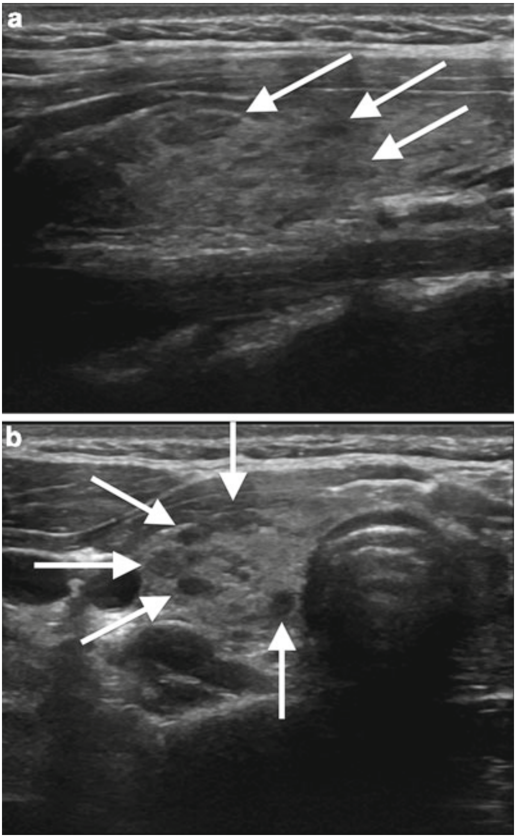

FIG. 5.17. Pseudonodules. Longitudinal (**a**) and transverse (**b**) US in a 14-year-old girl with chronic Hashimoto disease show innumerable rounded and oval hypoechoic foci known as pseudonodules (*arrows*).

FOCAL THYROID LESIONS

Focal thyroid nodules and masses are rare in children, accounting for less than 2% of pediatric thyroid diseases. Thyroid cancer in this age group is rarer still, occurring in less than 2 per 100,000 children. There are no specific imaging features unique to pediatric thyroid nodules and any dominant lesion should be biopsied as discussed in other chapters of this book.

The vast majority of pediatric thyroid nodules are benign, the most common diagnosis being benign follicular adenoma. Adenomas may have variable echogenicity, ranging from mostly

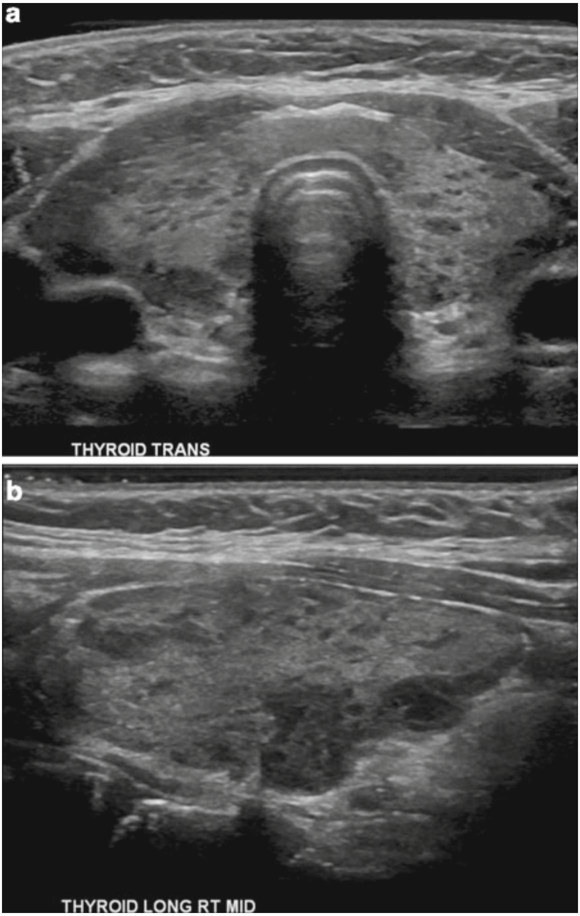

FIG. 5.18. Chronic Hashimoto disease. Transverse (**a**) and longitudinal (**b**) US in a 12-year-old boy show the typical appearance of chronic Hashimoto disease: a diffuse pattern of coarse reticular echoes and pseudonodules throughout the gland.

solid (Fig. 5.22) to mostly cystic (Fig. 5.23) masses. Other common benign thyroid lesions seen in children include colloid cysts and cystic degenerating or hemorrhagic nodules (Fig 5.24).

Like in adults, papillary carcinoma is the most common thyroid neoplasm in the pediatric age group. Unfortunately, it tends to behave more aggressively than in adults, with higher

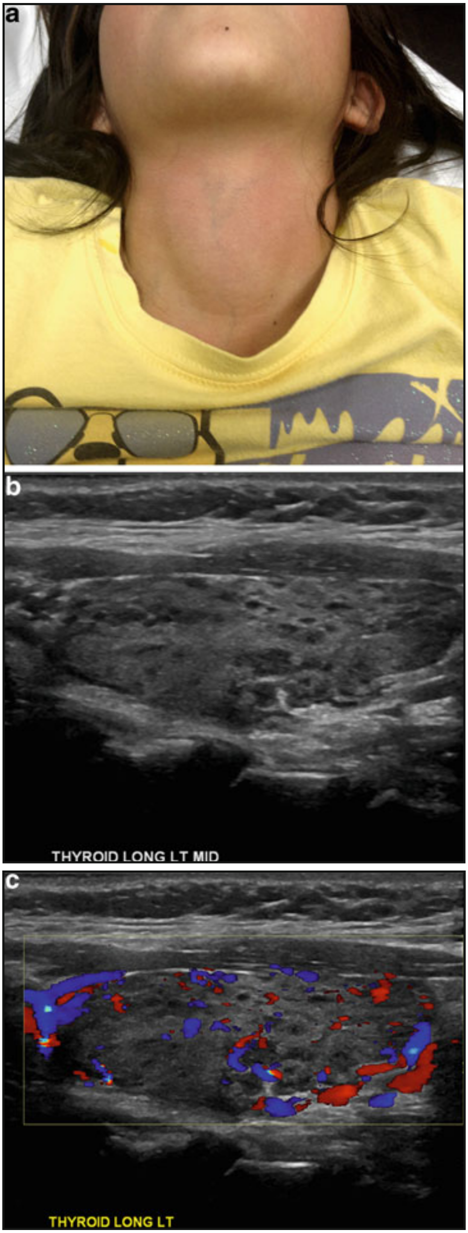

FIG. 5.19. Thyromegaly. Photograph (**a**) of a 9-year-old girl with severe thyroiditis shows marked enlargement of the thyroid gland. Grayscale (**b**) and color Doppler (**c**) images show the typical pattern of severe thyroiditis with innumerable pseudonodules. The gland is hyperemic and enlarged, with a volume over twice the upper limits of normal for her age.

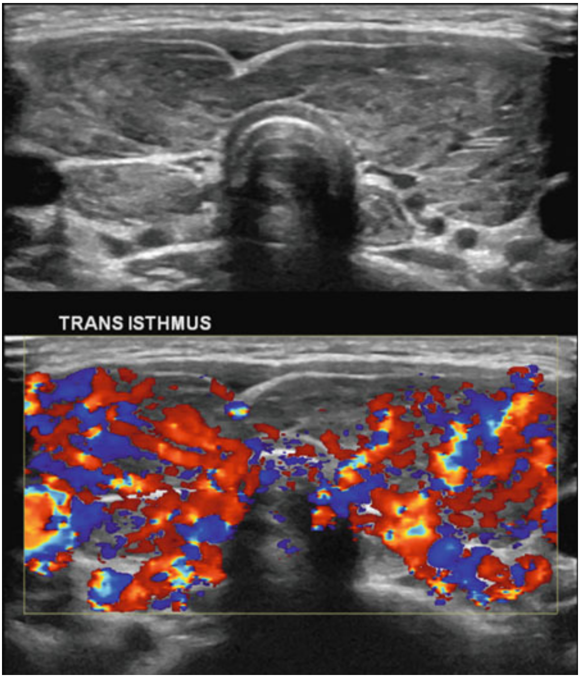

FIG. 5.20. Thyromegaly and hyperemia. Grayscale and color Doppler US images demonstrate diffuse thyroid enlargement and typical findings of severe thyroiditis. Note the diffuse, but inhomogeneous, pattern of hyperemia.

rates of multifocality, neck lymph node disease, and extracapsular extension (Fig 5.25). Other malignancies that may be seen include follicular carcinoma, medullary carcinoma, papillary oncocytic neoplasm, and metastatic disease, none of which have any specific imaging features.

SUMMARY

The most important concepts to remember about pediatric thyroid ultrasound can be distilled into two points. The first is that one must keep an open mind about what ultrasound of a "thyroid mass" may actually reveal in a child. The complex embryologic development of neck can result in disparate but predictable abnormalities that are, in fact, separate from the thyroid gland itself and

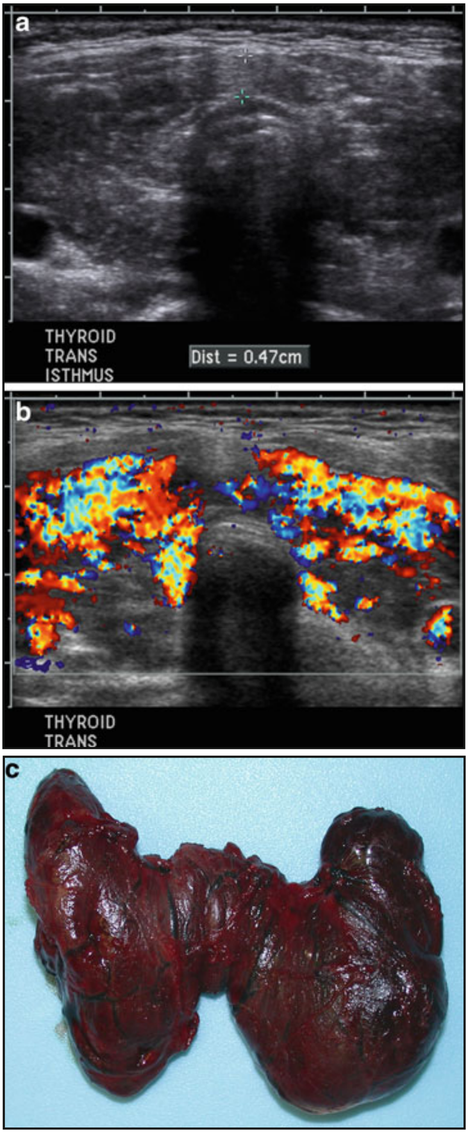

FIG. 5.21. Graves' disease. US cannot reliably differentiate between Hashimoto thyroiditis and Graves' disease in children. Grayscale (**a**) and color Doppler (**b**) US images in a 16-year-old girl with Graves' disease show sonographic features similar to those seen in Hashimoto thyroiditis, including diffuse enlargement, coarsening of the echotexture and echogenic septations. (**c**) A gross pathologic photograph of the thyroid from the same patient.

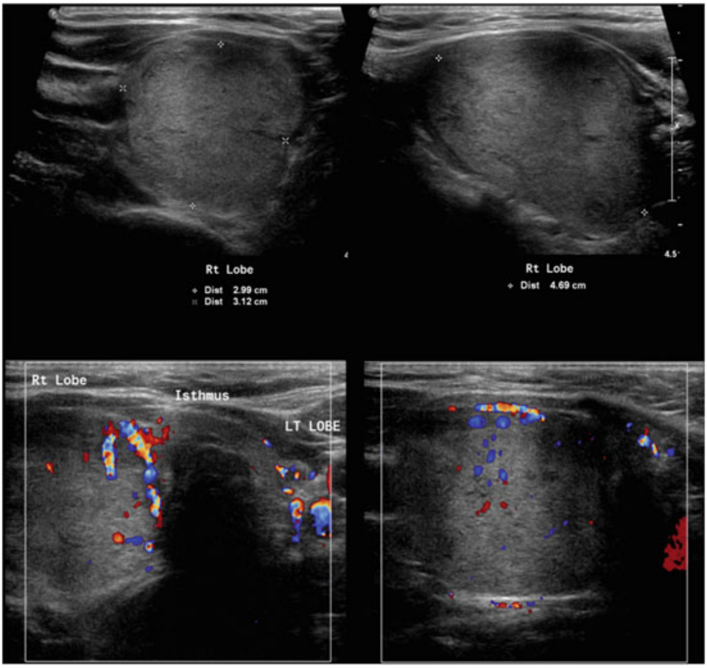

FIG. 5.22. Follicular adenoma. Imaging features of thyroid neoplasms are not specific. The most common thyroid neoplasm in children is benign follicular adenoma, which may range from completely solid to mostly cystic. Here, grayscale and color Doppler US images show a large, well-defined mass (*calipers*) in the right lobe of the thyroid of a 12-year-old boy with follicular adenoma.

the interpreting physician must be familiar with how to best diagnose these abnormalities, especially when further workup involves the use of other imaging techniques.

The second important concept to remember when performing pediatric thyroid ultrasound is that early thyroiditis may be quite subtle and often precedes the clinical detection of antithyroid antibodies in children. When imaging children with thyroiditis, one should be highly sensitive to subtle abnormalities seen in early disease. In children with chronic thyroiditis, the focus should be on the identification of any dominant nodule or regional lymphadenopathy. The sonographic approach and features of focal thyroid nodules in children is not unique and the other chapters of this text cover these topics in excellent detail.

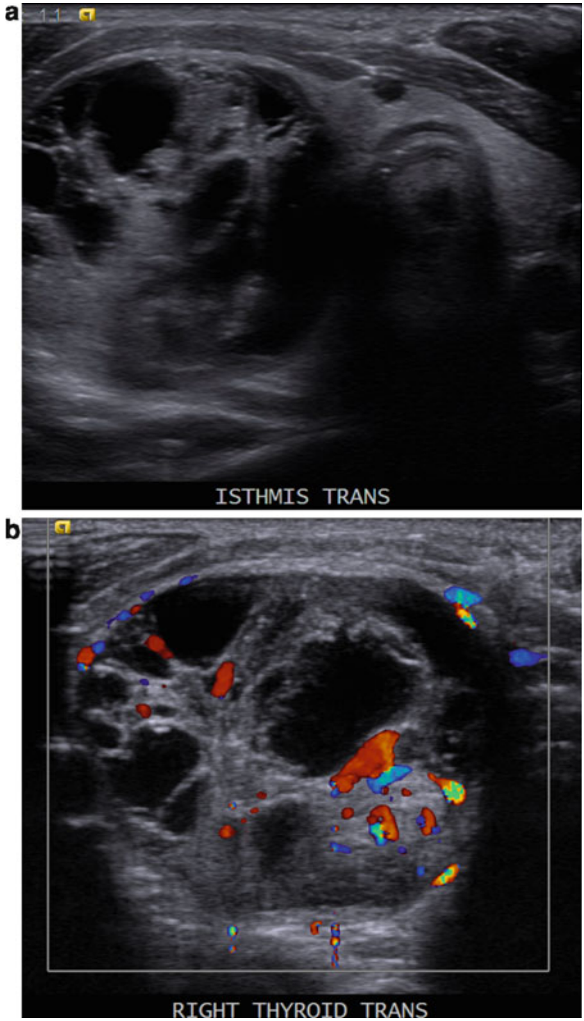

FIG. 5.23. Follicular adenoma. Transverse grayscale (**a**) and color Doppler (**b**) US images in a 17-year-old boy show an example of a mostly cystic follicular adenoma.

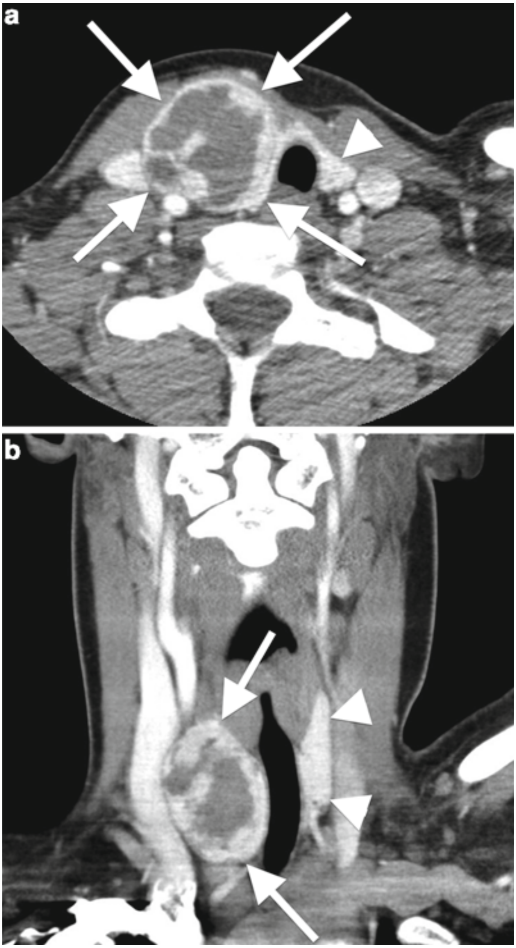

FIG. 5.24. Degenerating nodule. Axial (**a**) and coronal (**b**) enhanced CT in a 11-year-old boy with a long-standing thyroid mass show a nonspecific, partially enhancing cystic mass (*arrows*) found to be a degenerating nodule on pathology. Note the normal left thyroid lobe (*arrowheads*).

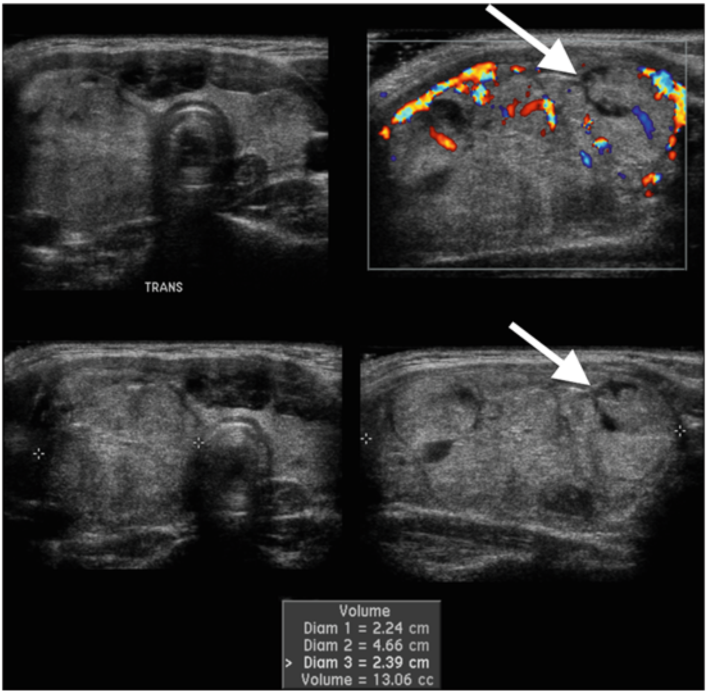

FIG. 5.25. Papillary carcinoma. Transverse (*top left & bottom left*) and longitudinal color Doppler (*top right*) and grayscale (*bottom right*) US images show a large, heterogeneous, multilobulated mass (*calipers*) almost replacing the entire right lobe of the thyroid in a 12-year-old boy. There is focal extracapsular extension (*arrows*) of this papillary carcinoma.

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