

Diagnostic Imaging in Nontraumatic Pediatric Head and Neck Emergencies¹

Benjamin J. Ludwig, MD • Bryan R. Foster, MD • Naoko Saito, MD
Rohini N. Nadgir, MD • Ilse Castro-Aragon, MD • Osamu Sakai, MD, PhD

ONLINE-ONLY CME

See www.rsna.org/education/rg_cme.html

LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

- Identify typical imaging features of common nontraumatic pediatric head and neck emergencies.
- Describe common complications of pathologic processes in the pediatric head and neck.
- Recognize congenital lesions of the head and neck and their associated complications, including superinfection.

Evaluation of pediatric patients in the emergency setting is complicated by a limited history and physical examination, which often produce findings that overlap with multiple disease processes. Imaging therefore plays a critical role in achieving an accurate and timely diagnosis. Knowledge of the typical clinical and imaging manifestations of common pediatric head and neck emergencies and congenital abnormalities allows the interpreting radiologist to identify the primary cause of the condition as well as any associated complications that may warrant immediate surgical management. The specific imaging protocol depends on the patient's clinical status. Radiography, ultrasonography, and contrast material-enhanced computed tomography all may be appropriate modalities for an initial examination. In especially difficult or complex cases, magnetic resonance imaging may offer additional detail with respect to the extent of disease.

©RSNA, 2010 • radiographics.rsna.org

RadioGraphics 2010; 30:781-799 • Published online 10.1148/rg.303095156 • Content Codes: ER HN NR PD

¹From the Department of Radiology, Boston University Medical Center, Boston University School of Medicine, 820 Harrison Ave, FGH Bldg, 3rd Floor, Boston, MA 02118. Presented as an education exhibit at the 2008 RSNA Annual Meeting. Received July 29, 2009; revision requested September 15 and received November 13; accepted November 20. For this CME activity, the authors, editors, and reviewers have no relevant relationships to disclose. Address correspondence to B.J.L. (e-mail: benjamin.ludwig@bmc.org).

Introduction

Although emergent conditions of the pediatric head and neck may involve abnormalities arising from the orbits to the airway, the clinical manifestations and associated complications of such conditions often overlap. Imaging therefore has a crucial role in the differential diagnosis and treatment of these conditions, although its use depends on the patient's clinical stability. To achieve an accurate diagnosis, radiologists must be familiar with the imaging appearances of infectious, inflammatory, congenital, and neoplastic conditions within the head and neck across all modalities. The article describes the clinical and imaging manifestations, differential diagnosis, and treatment of nontraumatic emergent conditions of the pediatric head and neck, including both congenital and acquired conditions and possible complications that may necessitate urgent management.

Orbital Abnormalities

It is imperative to distinguish between periorbital and orbital cellulitis. **Periorbital (preseptal) and orbital (postseptal) cellulitis are differentiated by their location with respect to the orbital septum. Their accurate characterization determines the aggressiveness of management, with the preservation of vision being of primary concern.**

Periorbital Cellulitis

Periorbital cellulitis involves the preseptal soft tissues anterior to the orbital septum, which is a thin sheet of fibrous tissue that originates in the orbital periosteum and inserts in the palpebral tissues along the tarsal plates (1). Patients present with eyelid swelling, erythema, chemosis, and possible limitation of eye movement in the absence of proptosis. These manifestations are secondary either to the contiguous spread of infection (from the face, teeth, or ocular adnexa) or to trauma (2).

Computed tomography (CT) and magnetic resonance (MR) imaging demonstrate induration and inflammation within the soft tissues anterior to the orbital septum (Fig 1) (2). Periorbital cellulitis is typically managed on an outpatient basis with antibiotics.

Orbital Cellulitis

Orbital cellulitis involves the postseptal soft tissues, which can be divided into intraconal (within the cone, which consists of the extraocular

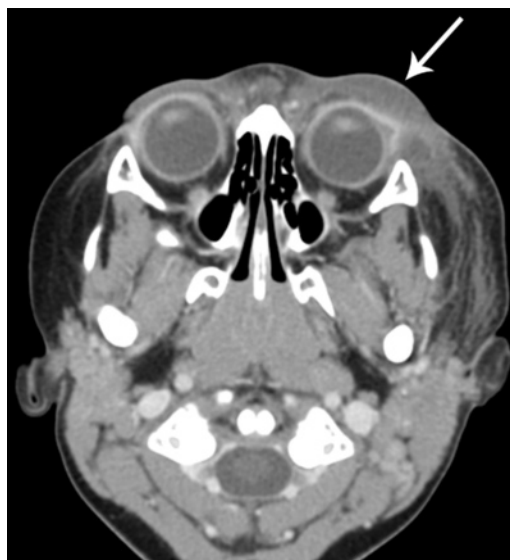


Figure 1. Periorbital cellulitis in a 2-year-old boy with eyelid swelling. Axial contrast material-enhanced CT image demonstrates preseptal soft tissue swelling overlying the left globe (arrow), with stranding within the subcutaneous tissues overlying the left zygoma.

muscles and an envelope of fascia [intermuscular membrane]), extraconal (outside the muscular cone, between the orbital bone and intermuscular membrane), and subperiosteal locations. Orbital cellulitis most commonly occurs secondary to paranasal sinusitis with perivascular spread of infection. Subperiosteal abscesses are often seen in teenagers and young adults and most commonly are associated with ethmoid sinusitis. Presenting symptoms are similar to periorbital cellulitis; however, proptosis may also occur.

CT findings include sinus opacification, retrobulbar stranding, and extraconal fluid collections adjacent to the orbital wall, with mass effect upon the extraocular muscles (Fig 2) (2). Of note, early abscesses do not necessarily demonstrate peripheral enhancement.

The differential diagnosis of orbital cellulitis includes inflammatory conditions such as orbital pseudotumor and orbital myositis, as well as intra- and extraorbital neoplasms.

Complications of orbital cellulitis include thrombosis of the superior ophthalmic vein and cavernous sinus, meningitis, and intracranial abscess formation (3). Although the incidence of intraconal abscesses secondary to sinus disease has decreased with antibiotic therapy, abscesses may be seen after ocular surgery and penetrating

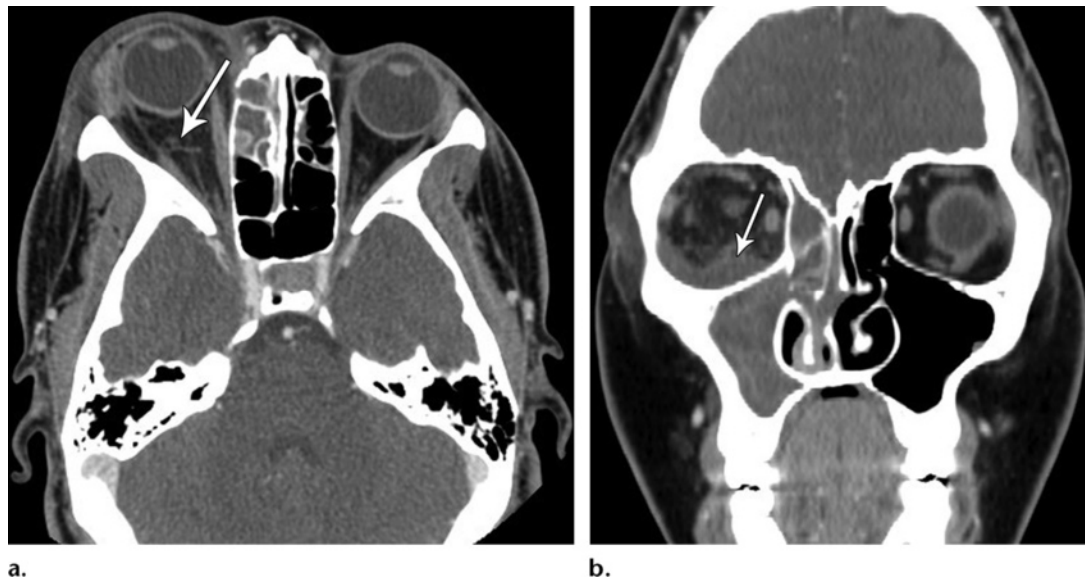


Figure 2. Orbital cellulitis with subperiosteal abscess in a 15-year-old girl with eyelid swelling and ophthalmoplegia. **(a)** Axial contrast-enhanced CT image depicts ethmoid opacification, lid edema, and proptosis on the right. Retrobulbar stranding (arrow) is characteristic of intraconal involvement and orbital cellulitis. **(b)** Coronal contrast-enhanced CT image shows subperiosteal soft tissue attenuation indicative of an abscess (arrow), with associated right frontal, ethmoid, and maxillary sinusitis.



Figure 3. Dacryocystitis in a 5-month-old boy with swelling and induration of the left eye. Axial contrast-enhanced CT image demonstrates a peripherally enhancing, hypoattenuating fluid collection at the level of the lacrimal sac, with associated preseptal inflammation.

orbital injury. CT findings of intraconal abscess include an intraconal fluid collection with peripheral enhancement (2).

Orbital cellulitis and subperiosteal abscesses are treated with intravenous antibiotics and pos-

sibly surgical drainage in the setting of vision impairment (3). The presence of an intraconal abscess usually requires surgical drainage (4).

Dacryocystitis

Dacryocystitis refers to inflammation and dilatation of the lacrimal sac, which is located along the medial (internal) canthus (5). Dacryocystitis is secondary to obstruction of the nasolacrimal duct, which may be related to ductal stenosis or a dacryolith. Patients present with a medial canthus mass, lid swelling, conjunctivitis, and a purulent discharge. The diagnosis is typically based on findings at clinical examination; however, lid swelling may preclude such examination and necessitate imaging.

Contrast-enhanced CT images depict a circumscribed hypoattenuating region centered in the lacrimal fossa with peripheral enhancement (Fig 3) (5). CT images also may depict complications such as periorbital or orbital cellulitis or underlying malignancy.

Lacrimal sac lesions may be secondary to noninfectious inflammatory causes such as sarcoidosis and Wegener granulomatosis, benign lesions such as mucoceles and epidermoid cysts,

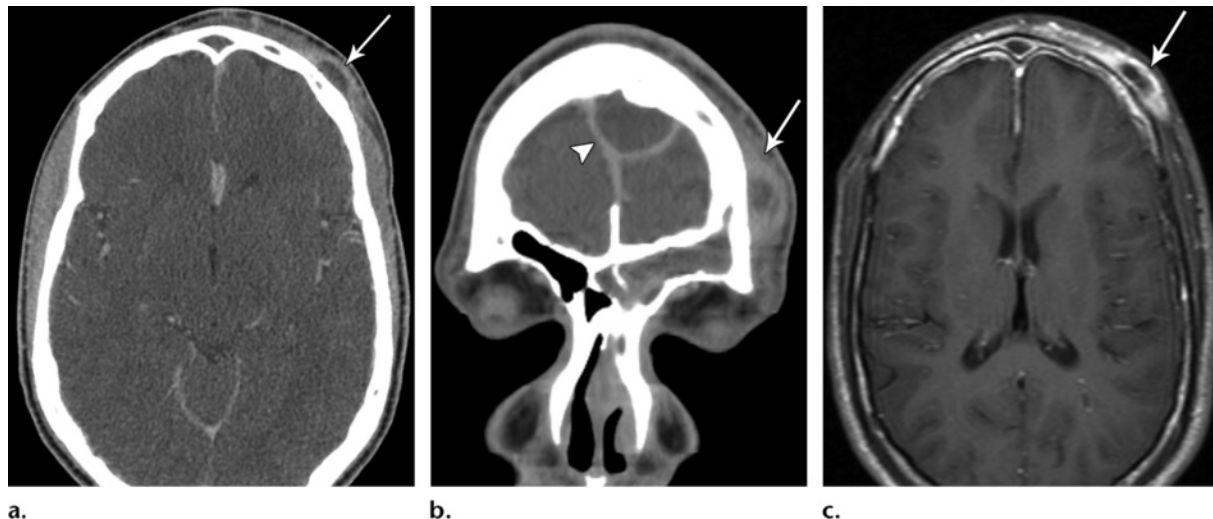


Figure 4. Pott puffy tumor in a 13-year-old boy with fever. **(a, b)** Axial **(a)** and coronal **(b)** contrast-enhanced CT images depict frontal sinus opacification and a subgaleal fluid collection with rimlike enhancement (arrow), findings consistent with a diagnosis of Pott puffy tumor. An associated epidural empyema (arrowhead in **b**) contributes to the mass effect on the left frontal lobe. **(c)** Axial contrast-enhanced T1-weighted MR image shows the subgaleal fluid collection (arrow), meningeal enhancement, and abnormal bone marrow enhancement due to osteomyelitis.

and malignant lesions, including squamous cell carcinoma and lymphoma. Malignancy, however, is rare in children.

Dacryocystitis may be treated medically (with antibiotics) or surgically (with dacryocystorhinostomy), depending on the clinical signs and symptoms (5).

Abnormalities of the Paranasal Sinuses

The maxillary sinuses begin to develop approximately 70 days after birth, followed by the ethmoid, sphenoid, and frontal sinuses. The paranasal sinuses are completely developed at 5–7 years of age (6).

Acute Sinusitis

Patients with acute sinusitis typically present with “cold” symptoms (eg, a cough), purulent nasal discharge, and fever (6). The cause of sinusitis is typically infection, which may be bacterial, viral, or fungal.

CT and MR imaging findings in acute sinusitis may include mucosal thickening, sinus opacification, air-fluid levels, and mucosal enhancement. However, such abnormalities may be seen in as many as 50% of patients undergoing CT or MR imaging for other reasons and thus lack diagnostic specificity for sinus disease (7). In addition, the imaging appearance often does not correspond to the severity of disease (6). For these

reasons, the diagnosis of acute sinusitis should rest on clinical rather than radiologic findings. The American College of Radiology does not currently recommend imaging for the diagnosis of acute, uncomplicated sinusitis (7).

The differential diagnosis for nonspecific imaging findings of acute sinusitis includes mucus retention cysts simulating an air-fluid level, hemorrhage, and postobstructive secretions.

Although CT and MR imaging lack specificity for the diagnosis of acute sinusitis, either modality may be appropriately used to identify sinusitis-related complications. Such complications include orbital cellulitis, osteomyelitis, Pott puffy tumor, intracranial extra-axial empyema, brain abscess, meningitis, and mucocele (8).

Sinusitis typically is self-limiting and is treated with antibiotics; however, complications often manifest emergently and require urgent treatment and surgical intervention.

Pott Puffy Tumor

Pott puffy tumor has a unique imaging appearance that may be described as an enlarging “doughy” fluctuance overlying the brow. This condition results from frontal sinusitis that leads to thrombophlebitis within the valveless emissary veins, necrosis of the inner and outer tables of the skull, and subperiosteal abscess formation (8).

Imaging findings of Pott puffy tumor include sinus opacification, osseous destruction of the frontal bone, a frontal subgaleal fluid collection, and soft tissue swelling (Fig 4).

Teaching Point

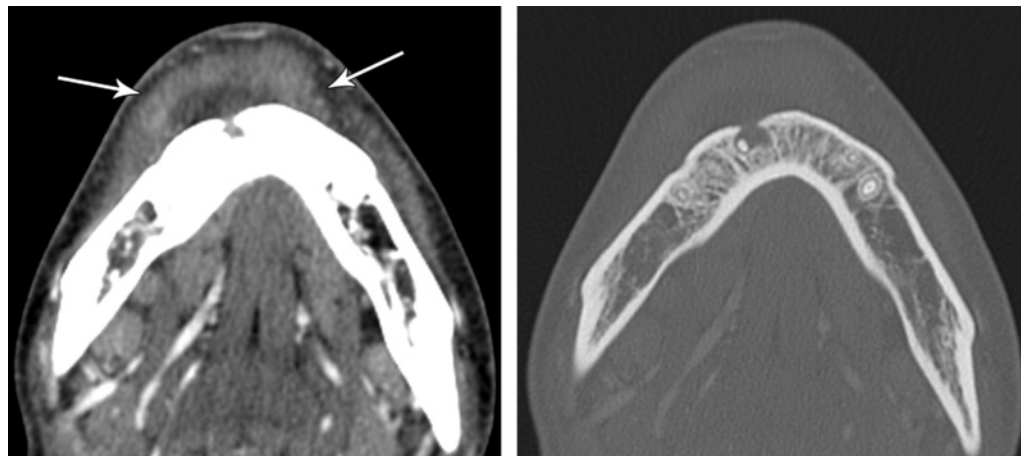


Figure 5. Odontogenic abscess in a 19-year-old woman with chin swelling. **(a)** Axial contrast-enhanced CT image (soft tissue window) demonstrates a peripherally enhancing fluid collection that is closely associated with the parasymphyseal mandible (arrows). **(b)** Axial contrast-enhanced CT image (bone window) shows a periapical lucency with buccal cortical breakthrough. Sclerosis of the symphyseal mandible is suggestive of underlying chronic inflammation.

Dermoid and epidermoid cysts, cephaloceles, and cephalhematomas also may produce frontal soft tissue swelling; however, the imaging findings and clinical history allow their differentiation from Pott puffy tumor. Mucocoeles and destructive lesions with soft tissue components (eg, Langerhans cell histiocytosis, metastases) also should be considered in the differential diagnosis.

Possible complications of Pott puffy tumor include cavernous sinus thrombosis (9), thrombophlebitis, venous infarct, subdural and epidural empyema, and parenchymal abscess (10).

Treatment is surgical, with drainage of the subperiosteal abscess, débridement of necrotic bone, and broad-spectrum intravenous antibiotics for a minimum of 6 weeks (8).

Maxillofacial Abnormalities

Odontogenic Infection

Tooth decay is the most common chronic illness in the pediatric population, affecting 50% of children aged 9 years or less and 80% of those aged 17 years or less (11). In addition, the emergency room often serves as the site of primary dental care for many pediatric patients (12). Periodontal abscesses are a common manifestation of dental disease and are associated with multiple potentially life-threatening complications.

Odontogenic infection may spread in two ways. The first pathway is provided by the formation of dental caries, which allow bacteria to enter the tooth and spread to its apex (root), with resultant apical periodontitis, granuloma, abscess,

and finally, radicular cyst formation. The second involves bacterial overgrowth and inflammation in the space between the tooth and the gum, which eventually leads to the destruction of periodontal ligaments and erosion of bone. A focal abscess also may form at the root of the tooth.

Patients with odontogenic abscesses present with fever, tooth pain, facial swelling, dysphagia, trismus, and possibly dyspnea. Suspected odontogenic abscesses are best evaluated with contrast-enhanced CT, which demonstrates a periodontal lucency that extends into adjacent soft tissues through a focal cortical break or fistula, with an extrasosseous fluid collection that shows rimlike enhancement (13) (Fig 5). Complications of an odontogenic abscess include the spread of infection into the deep spaces of the neck and orbit, airway compromise, internal jugular vein thrombosis, and intracranial extension of infection (14).

Treatment includes antibiotics with possible abscess drainage and definitive management (root canal or extraction) of the offending tooth.

Ludwig Angina

Ludwig angina is a necrotizing infection of the floor of the mouth that involves the submandibular spaces bilaterally (15). The infection is odontogenic in an estimated 90% of cases (16) but also may result from penetrating trauma.

Ludwig angina is most commonly seen in patients with an odontogenic infection involving

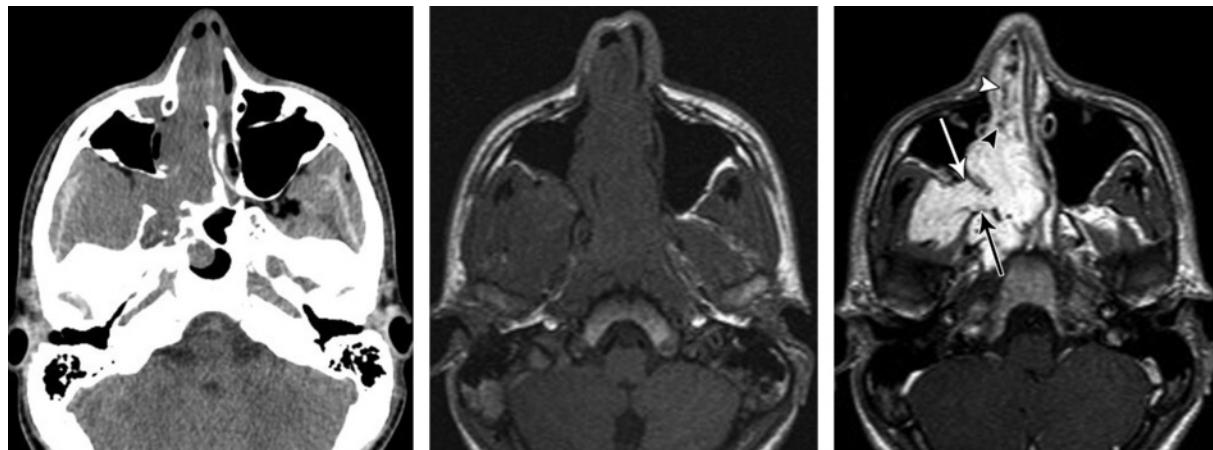
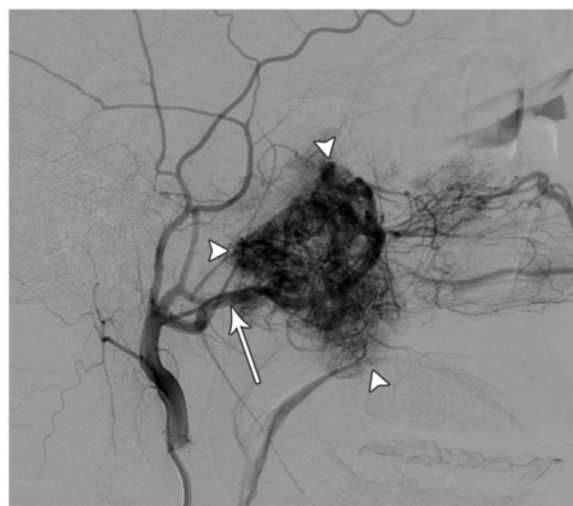


Figure 6. Juvenile angiofibroma in a 15-year-old boy with recurrent epistaxis. **(a)** Axial unenhanced CT image depicts a homogeneous mass centered in the sphenopalatine foramen. The mass extends into the nasal cavity and widens the pterygopalatine fossa. **(b, c)** A comparison of axial unenhanced **(b)** and contrast-enhanced **(c)** T1-weighted MR images shows avid enhancement of the mass (arrows in **c**). Note the flow voids in the pterygopalatine fossa (arrowheads in **c**). **(d)** Right external carotid artery angiogram shows the feeding internal maxillary artery (arrow) and the hypervascular lesion (arrowheads).



d.

the second and third mandibular molars, because these tooth apices extend inferiorly to the mandibular insertion of the mylohyoid muscle (14), thus allowing direct extension of infection into the submandibular space. From there, infection may spread into other fascial spaces of the neck and may lead to airway compromise and mediastinitis (14). Predisposing factors include poor dental hygiene, diabetes, compromised immune status, and intravenous drug abuse. However, Ludwig angina may occur in children without any known predisposition (16). Patients present with symptoms of odontogenic abscess, jaw and neck swelling, elevation of the tongue, and stridor (14).

Imaging is performed to evaluate for mass effect on the airway, gas-forming organisms and drainable abscesses, and underlying dental disease. In the presence of Ludwig angina, CT and MR images show local skin thickening, increased attenuation of subcutaneous fat, muscle enlargement, and loss of fat planes within the submandibular space. CT images also may depict soft tissue emphysema and focal fluid collections within the fascial spaces of the neck (16).

Complications of Ludwig angina include mandibular osteomyelitis, spread of infection into the deep fascial spaces of the neck, and thrombophlebitis of the internal jugular vein (Lemierre syndrome) (14).

Early recognition and treatment are vital. Treatment is aimed at securing the airway and includes intravenous antibiotics and surgical decompression of the submandibular space (14). Ludwig angina is associated with a mortality rate of up to 10% (17).

Juvenile Angiofibroma

Although nasal abnormalities rarely manifest emergently, epistaxis is a common reason for emergency department visits. In pediatric patients, recurrent atraumatic epistaxis associated with nasal obstruction may be a sign of juvenile angiofibroma, a benign but locally aggressive vascular tumor that typically affects adolescent boys.

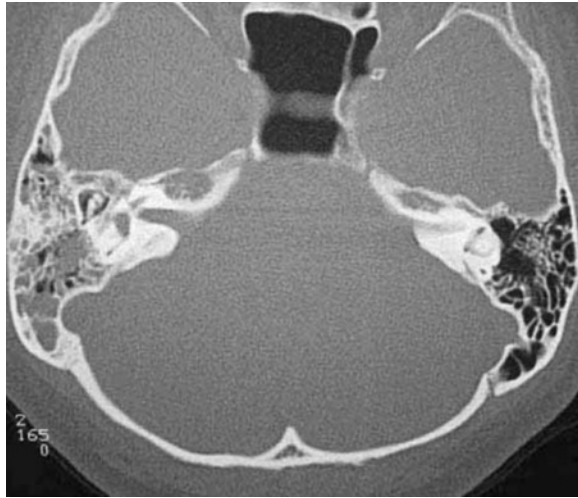


Figure 7. Serous otitis media in an 8-year-old girl with otalgia. Axial unenhanced CT image demonstrates near complete opacification of the right mastoid air cells, with no evidence of mastoid sclerosis or osseous destruction.

CT and MR imaging are both appropriate modalities for initial diagnostic imaging of pediatric patients with recurrent epistaxis. On CT images, a juvenile angiofibroma appears as a soft tissue mass that is centered within the sphenopalatine foramen. On contrast-enhanced CT images, the mass shows avid enhancement. At the time of diagnosis, the mass classically involves the pterygopalatine fossa; in this location, it produces a bowed appearance of the posterior wall of the maxillary sinus and widening of the pterygopalatine fossa and inferior orbital and pterygomaxillary fissures (Fig 6a–6c) (18). Osseous erosion of the nasal cavity, hard palate, and pterygoid plates is also common. MR imaging is superior to CT for definition of tumor extension into soft tissues of the skull base or intracranially. The lesion typically shows low signal intensity on T1-weighted images, heterogeneous intermediate signal intensity on T2-weighted images, and avid enhancement with flow voids on contrast-enhanced MR images (18). These imaging features, along with the patient's age, can help differentiate a juvenile angiofibroma from other nasopharyngeal lesions.

Before treatment, angiography is often performed to define the vascular supply of the lesion. Most often, the ipsilateral internal maxillary artery, ascending pharyngeal artery, or palatine artery provides the dominant supply (19). However, the mass also may involve branches of the contralateral internal and external carotid

arteries; therefore, bilateral internal and external carotid artery angiography is necessary for treatment planning (Fig 6d).

Surgical resection is the reference standard for management of juvenile angiofibromas, and preoperative embolization may be performed to reduce the risk of intraoperative hemorrhage (20). Radiation therapy may be used to treat unresectable tumors with intracranial extension (21).

Temporal Bone Abnormalities

Acute Otitis Media and Complications

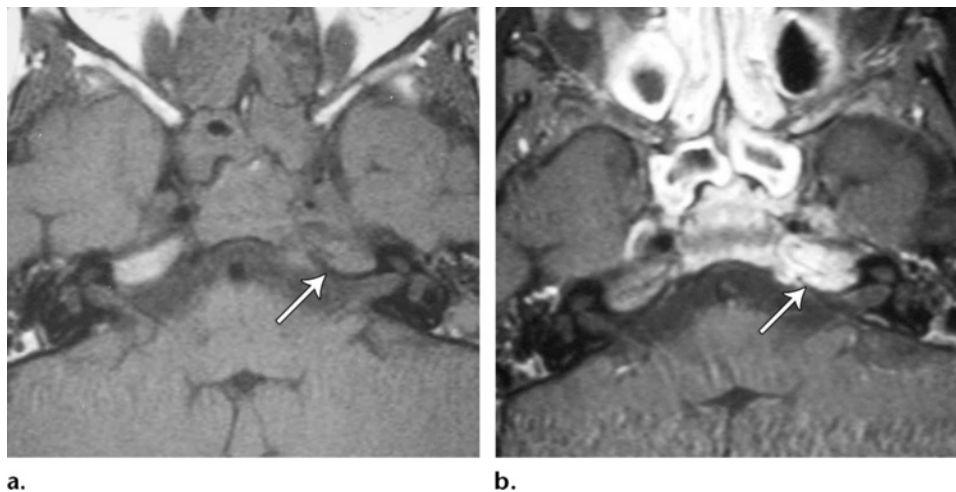
Acute otitis media, which is defined as inflammation involving the middle ear, is the most commonly occurring infection in the first 5 years of life (22). In most patients, the condition is readily diagnosed clinically and resolves after treatment with antibiotics. However, complications occur in approximately 18% of cases (22), and in these cases CT of the temporal bone plays a crucial diagnostic role.

Patients with serous otitis media typically present with otalgia and otorrhea, but nonspecific symptoms of irritability and difficulty with feeding or sleeping are also common in young children. CT findings include opacification of the middle ear and mastoid air cells, which may contain air-fluid levels (Fig 7). Findings typically resolve after adequate therapy.

Acute mastoiditis results from obstruction of the mastoid antrum. Children with this condition have prolonged symptoms of otitis media with retroauricular pain, erythema, and swelling. CT demonstrates middle ear fluid and opacification of the mastoid air cells, without osseous resorption. Like serous otitis media, acute mastoiditis usually resolves with antibiotic treatment (22).

Mastoid abnormalities also may be secondary to Langerhans cell histiocytosis, rhabdomyosarcoma, and metastatic disease (most commonly neuroblastoma). Along with the clinical history, a careful imaging evaluation to identify osseous destruction is essential to make the diagnosis. The presence of cranial nerve involvement significantly increases the likelihood that a malignancy is present. Fibrous dysplasia may also occur in the skull base and temporal bone, producing the typical ground-glass appearance with involvement of contiguous bones.

Figure 8. Petrous apicitis in a 6-year-old girl with fever and otorrhea. **(a)** Axial T1-weighted MR image demonstrates signal hypointensity representing soft tissue within the left petrous apex (arrow). **(b)** Axial contrast-enhanced fat-saturated T1-weighted image depicts avid petrous apex enhancement (arrow), a finding indicative of acute inflammation due to infection.



Petrous apicitis, another complication of acute mastoiditis, results from the direct spread of infection to pneumatized petrous apices. Clinical symptoms include sixth cranial nerve palsy, deep facial pain, and ipsilateral otorrhea. When these symptoms occur together, they are referred to as Gradenigo syndrome. CT findings include opacification of the petrous apex with osseous erosion (22). MR characteristics include signal hyperintensity in the petrous apex on T2-weighted images and avid enhancement after the administration of contrast material (Fig 8). These findings should be differentiated from those seen in the presence of an effusion, in which the osseous septa are intact. Additional complications of mastoiditis include labyrinthitis, facial nerve paralysis, meningitis, epidural abscesses, and dural venous sinus thrombosis. Carotid artery involvement is the most feared complication; such involvement may result in arteritis, occlusion, pseudoaneurysm, or rupture (22).

Erosion of the mastoid septa or cortex with periosteal reaction is seen in coalescent mastoiditis. Infection in coalescent mastoiditis is more likely to cause intra- and extracranial complications by direct extension. The process may extend laterally to erode the external mastoid cortex, with a resultant subperiosteal abscess (Fig 9b). Osseous erosion may also involve the mastoid tip, leading

to the formation of a Bezold abscess within the soft tissues inferior to the mastoid (22). Although the relative merits of various management methods are still debated, surgical drainage is usually required; thus, radiologic recognition of coalescent mastoiditis is crucial.

Necrotizing External Otitis (Malignant Otitis Externa)

Infection of the external auditory canal (classically, with *Pseudomonas aeruginosa*) results in external otitis (23). This type of infection may be seen in immunocompromised children but is more common in elderly and diabetic patients. It commonly spreads from the external auditory canal to soft tissues adjacent to the temporal bone, including the temporomandibular joint, middle ear, mastoid air cells, and skull base.

Patients typically present with otalgia, otorrhea, and headache. Granulation tissue is seen within the external auditory canal at physical examination, and an elevated erythrocyte sedimentation rate is found at laboratory analysis (23).

CT and MR imaging demonstrate soft tissue lesions within the external auditory canal and osseous erosion of the canal itself. Fluid may be seen in the middle ear and mastoid air cells. Soft tissue extension inferior to the temporal bone most often is observed as abnormal signal intensity or abnormal attenuation and obliteration of fat within the stylomastoid foramen (Fig 10) (23). Osseous erosion of the central skull base also may be seen. MR imaging is the preferred

Figure 9. Acute mastoiditis with abscess in an 11-month-old girl with otalgia and swelling. **(a)** Axial contrast-enhanced CT image (bone window) depicts bilateral opacification of the middle ears and mastoid air cells. **(b)** Axial contrast-enhanced CT image (soft tissue window) shows a peripherally enhancing fluid collection (arrows) overlying the right temporal bone, a finding indicative of an abscess.

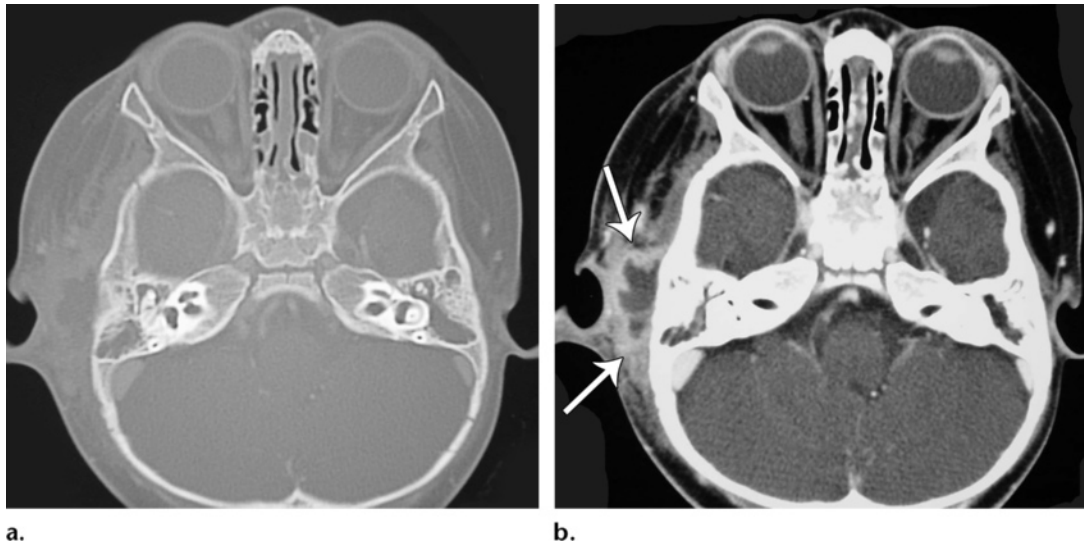
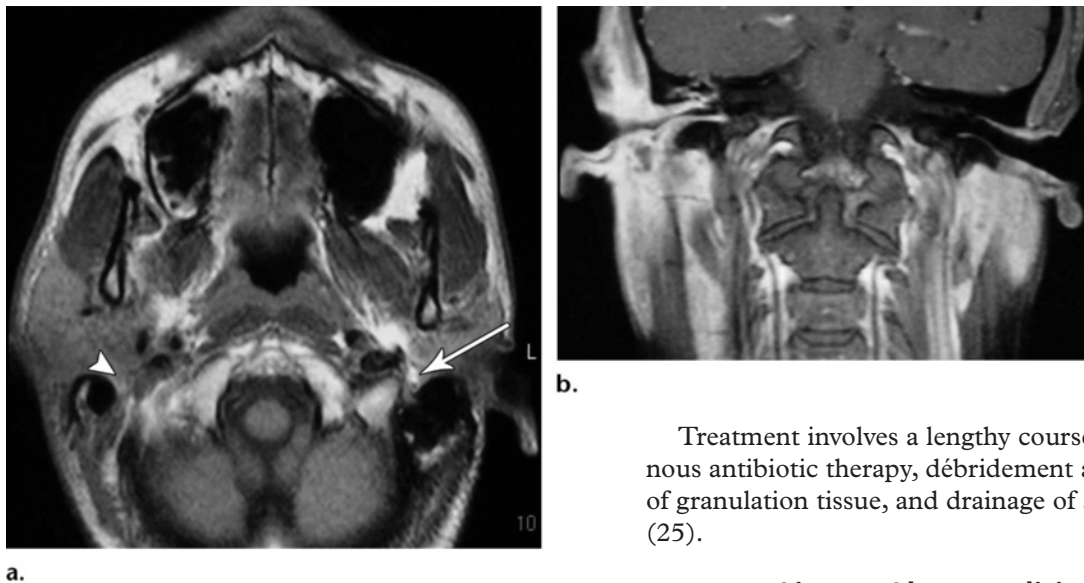


Figure 10. Necrotizing external otitis in a 19-year-old man with insulin-dependent diabetes mellitus and otalgia. **(a)** Axial T1-weighted MR image shows abnormal low signal intensity in the right stylomastoid foramen (arrowhead) and stranding in the subcutaneous fat. Note the appearance of normal fat signal intensity in the left stylomastoid foramen (arrow). **(b)** Coronal contrast-enhanced T1-weighted MR image demonstrates mucosal thickening and enhancement within the right external auditory canal, with resultant canal narrowing.



Treatment involves a lengthy course of intravenous antibiotic therapy, débridement and biopsy of granulation tissue, and drainage of abscesses (25).

Airway Abnormalities

Epiglottitis

Acute epiglottitis is one of the most serious emergent conditions of the pediatric head and neck because of its association with airway compromise. Fever, sore throat, drooling, posturing

modality for detecting soft tissue or bone marrow signal intensity abnormalities and involvement of the facial nerve (23).

Nonnecrotizing external otitis shares many imaging features with necrotizing external otitis but lacks osseous erosion (23). The differential diagnosis includes cholesteatoma or squamous cell carcinoma of the external auditory canal (24).



Figure 11. Epiglottitis in an 18-year-old woman with dyspnea. Lateral neck radiograph demonstrates marked bulbous thickening of the epiglottis, a finding known as the thumb sign.



Figure 12. Neck radiograph obtained in a pediatric patient shows a normal subglottic airway with a normal convex shape of the shoulders.

with neck extension, and respiratory distress are common clinical symptoms of the condition (26). Historically, acute epiglottitis occurred most often in children between the ages of 1 and 5 years, with *Haemophilus influenzae* being the most common causative pathogen. However, with the routine vaccination of children, the frequency of such occurrences has decreased markedly.

Epiglottitis is normally diagnosed on the basis of clinical findings, and imaging should be performed only if necessary and if it will not interfere with bronchoscopy or maintenance of airway patency. If the patient's condition permits, lateral neck radiography is the preferred modality. Thickening of the epiglottis (the "thumb sign") and aryepiglottic folds is a characteristic finding (Fig 11) (19).

CT is neither necessary nor recommended in the acute setting; however, CT images obtained in patients with unsuspected epiglottitis reveal a thickened epiglottis and narrowing of the airway as well as extension of the inflammatory process into the adjacent deep spaces of the neck (26).

CT also may be performed if a cause of epiglottic and aryepiglottic fold thickening other than epiglottitis is suspected. Other possible causes of this finding include the ingestion of a caustic

substance or foreign body, angioedema, hemorrhage, epiglottic cyst, and postirradiation edema and fibrosis.

Endoscopy is performed emergently to confirm the diagnosis. Treatment measures include securing an airway and initiating intravenous antibiotics.

Laryngotracheobronchitis

Laryngotracheobronchitis, or croup, most commonly occurs between the ages of 6 months and 3 years. Various viral causes, including parainfluenza, are most commonly implicated (26). The disease onset is signaled by prodromal symptoms of viral infection, which are followed by fever, inspiratory stridor, hoarseness, and a classic "barking" cough. The condition typically occurs during the fall and winter months.

In pediatric patients in whom croup is suspected, imaging is performed to determine whether another cause of inspiratory stridor is present that may require emergent intervention (such causes might include epiglottitis and foreign body ingestion). Frontal radiographs demonstrate symmetric straightening of the normally convex appearance of the "shoulders" of the subglottic airway, a finding also referred to as the "steeple sign." Lateral radiographs show narrowing of the subglottic airway with distention of the hypopharynx (Figs 12, 13) (19).

Teaching
Point

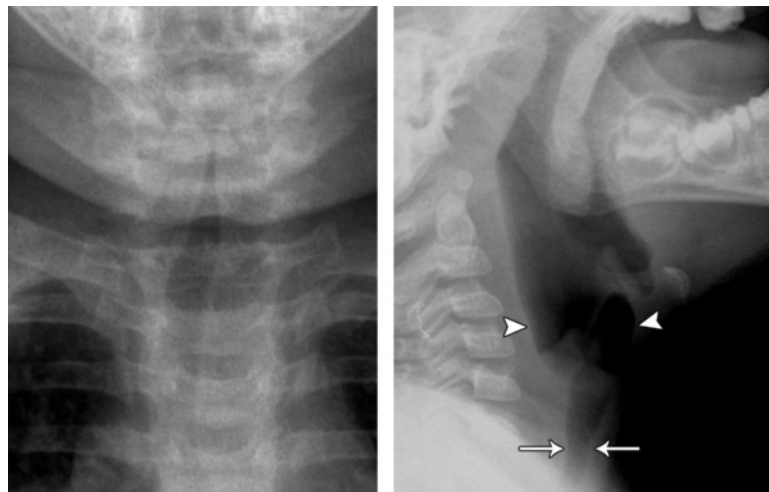


Figure 13. Neck radiographs obtained in a 3-year-old boy with croup show abnormal appearances of the subglottic airway. **(a)** Frontal radiograph demonstrates tapering of the subglottic airway with a loss of the normal convex appearance of the shoulders. **(b)** Lateral radiograph depicts subglottic airway narrowing (arrows) and hypopharyngeal overdistention (arrowheads).

Differential considerations include subglottic stenosis (congenital or related to prior intubation), inflammatory causes such as Wegener granulomatosis, and developmental lesions such as subglottic hemangioma.

Croup is often managed on an outpatient basis with oral and inhaled corticosteroids. Inpatient management, possibly with intubation, is reserved for severe cases (26).

Foreign Body Aspiration and Ingestion

The aspiration of foreign bodies most often occurs in children between the ages of 1 and 3 years, and the aspirated object is most commonly found in the right main stem bronchus (27). Less often, foreign bodies become lodged in the upper airway (most commonly the valleculae, epiglottis, vocal folds, and subglottis) (28). Peanuts, seeds, and beans are the foreign bodies most commonly aspirated (28). Patients present with an abrupt onset of respiratory distress and paroxysmal cough.

If the patient's clinical status is stable enough to allow plain radiography, anteroposterior and lateral neck and chest radiographs are obtained (Fig 14). Unfortunately, most aspirated foreign bodies are radiolucent (80%), resulting in appar-

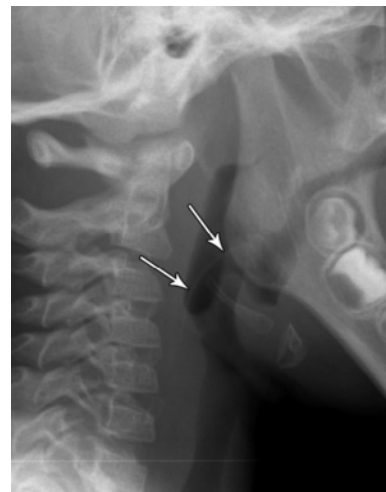


Figure 14. Pharyngeal foreign body in a 3-year-old girl with dysphagia. Lateral neck radiograph shows a curvilinear radiopaque foreign body lodged within the oropharynx and hypopharynx (arrows). A fishbone was extracted.

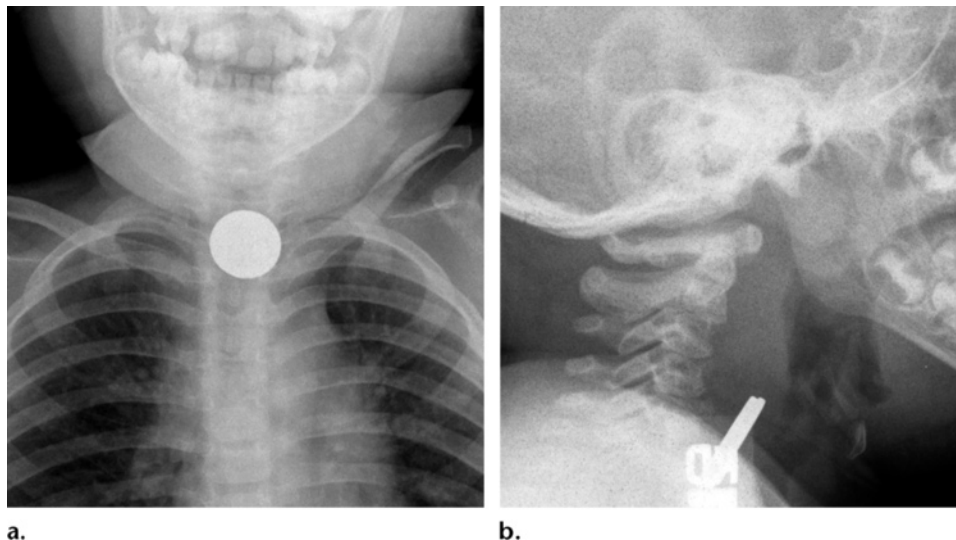
ently normal radiographs (28). Air trapping, a secondary sign of a foreign body, may be seen on expiratory or bilateral decubitus views. Hyperinflation despite expiration or dependent positioning is indicative of air trapping secondary to a foreign body.

Diagnostic bronchoscopy is performed in the presence of positive findings at clinical, physical, or radiographic examination. With early recognition, the mortality from airway foreign bodies is less than 1% (28).

Foreign bodies that are ingested also may become lodged in the esophagus. This occurs most often at the cricopharyngeus muscle, the level of the aortic arch impression on the esophagus, the lower esophageal sphincter, and sites of underlying disease (ie, vascular rings, strictures) (28). Coins and food are the foreign bodies most commonly recovered from the esophagus in pediatric patients (27). Clinical manifestations of this condition vary but commonly include irritability, poor feeding, and coughing.

Radiography is the primary modality for diagnostic imaging evaluation. Esophageal foreign bodies are typically oriented in a craniocaudal

Figure 15. Esophageal foreign body in a 3-year-old boy. **(a)** Frontal neck radiograph depicts a round radiopaque foreign body in the upper esophagus. **(b)** Lateral radiograph demonstrates two stacked foreign bodies posterior to the larynx, within the upper esophagus. Two pennies were retrieved at endoscopy.



direction, are located posterior to the trachea on lateral radiographs, and often exert mass effect on the posterior trachea (Fig 15) (27).

Clinically stable patients can be treated conservatively. Patients whose status is unstable may require endoscopy or balloon-tip catheter extraction. Complications include esophageal perforation and mediastinitis. The longstanding presence of a foreign body can lead to tracheo-esophageal or aorto-esophageal fistulization (28).

Tonsillar Disease

Approximately 45,000 cases of tonsillitis occur annually within the United States, with one-third of those cases occurring in the pediatric population (29). The diagnosis of acute tonsillitis generally is based on clinical findings, and the condition is treated with antibiotics.

As a complication of untreated or incompletely treated tonsillitis, a peritonsillar abscess may arise between the tonsillar capsule and pillar. Patients with a peritonsillar abscess present with fever, sore throat, and dysphagia. The diagnosis of a peritonsillar abscess is based on clinical findings, but needle aspiration or intraoral ultrasonography (US) may be performed for confirmation.

The role of imaging in the diagnosis of tonsillar disease is to help differentiate tonsillitis from peritonsillar abscess. Imaging is particularly useful in the presence of atypical clinical manifestations, trismus that limits physical examination, failure of resolution despite adequate antibiotic

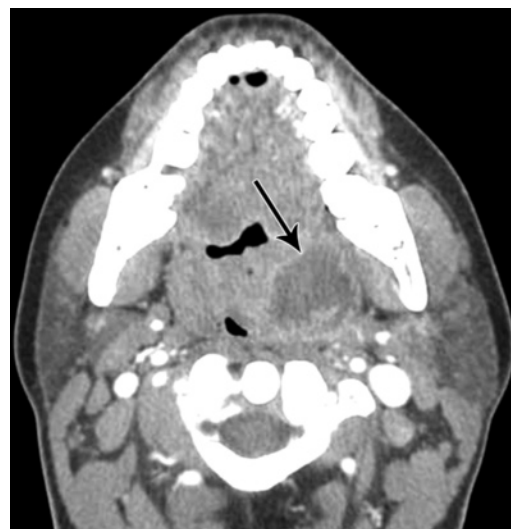


Figure 16. Peritonsillar abscess in a 17-year-old boy with fever, sore throat, and trismus. Axial contrast-enhanced CT image demonstrates a peripherally enhancing fluid collection in the left peritonsillar region (arrow). Note the mass effect on the oropharynx.

treatment, or clinical suspicion of the extension of tonsillar disease into the deep spaces of the neck (14).

Contrast-enhanced CT findings in the presence of a peritonsillar abscess include diffuse enlargement and enhancement of the tonsil, with an associated fluid collection exhibiting rimlike enhancement (Fig 16). Differentiation of a peritonsillar abscess from a necrotic retropharyngeal lymph node may be difficult on the

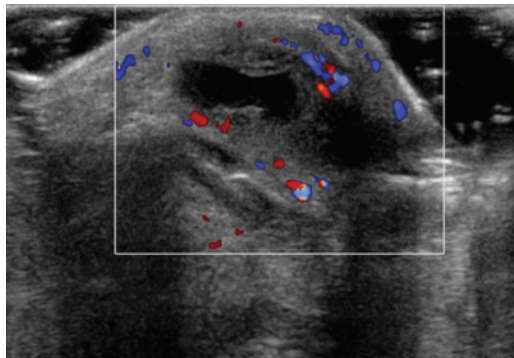


Figure 17. Infected thyroglossal duct cyst in an 8-year-old boy with a midline neck mass. Color Doppler US image obtained in the anterior part of the neck shows an anechoic cystic structure with a thickened irregular wall and hyperemia, findings suggestive of superinfection of a thyroglossal duct cyst.



Figure 18. Thyroglossal duct cyst in a 14-year-old boy with neck swelling. Axial contrast-enhanced CT image depicts a rounded region of hypoattenuation within the left strap muscles at the level of the thyroid cartilage.

basis of location alone. The parapharyngeal and retropharyngeal spaces are the deep neck spaces most commonly affected by direct extension of tonsillar disease (14).

In the presence of tonsillar enlargement, other entities that should be considered in the differential diagnosis include lymphoid hyperplasia, infectious conditions such as mononucleosis, tonsillar neoplasms such as squamous cell carcinoma and lymphoma, and inflammatory conditions

such as angioedema and mucositis secondary to Kawasaki disease.

Peritonsillar abscesses are commonly treated with surgical drainage.

Neck Abnormalities

It is critical to identify common congenital lesions, such as branchial cleft cysts and thyroglossal duct cysts, and to recognize their complications, which may include superinfection.

Teaching Point

Thyroglossal Duct Cysts

The thyroglossal duct is lined by secretory epithelium and connects the foramen cecum at the base of the tongue to the thyroid. The duct typically involutes between the 8th and 10th gestational weeks; however, if involution fails, a cyst may arise anywhere along the surface of the functioning secretory epithelium (29). Most thyroglossal duct cysts are closely associated with the hyoid bone or invested in the strap muscles, typically within 2 cm of the midline (30). Patients present with a neck mass that moves cephalad during swallowing or extension of the tongue or with symptoms of infection, including swelling, pain, erythema, and fever.

US demonstrates a circumscribed lesion in the characteristic location, with intralésional echogenicity depending on the proteinaceous content of the cyst (the higher the protein content, the more echogenic the lesion) (30). The presence of a thick external wall or internal septa is suggestive of superinfection (Fig 17) (31). Findings at contrast-enhanced MR imaging and CT include a thin-walled cyst in the appropriate location (Fig 18). The rim may enhance even in the absence of infection; however, an irregular thick enhancing rim with surrounding inflammatory change is indicative of superinfection (30). Enhancing material within the cyst may represent ectopic thyroid tissue, and calcifications are often seen in an evolving papillary thyroid carcinoma.

The differential diagnosis of a midline neck mass includes epidermoid or dermoid cyst, lymph node, and abscess. However, these lesions typically are found in locations superficial to the strap muscles. The clinical manifestations and the findings at physical and imaging examinations should aid in narrowing the differential diagnosis.

Figure 19. Second branchial cleft cyst in a 6-year-old boy with a neck mass. Axial contrast-enhanced CT image demonstrates a rounded region of hypoattenuation (arrow) with a location anteromedial to the sternocleidomastoid muscle (arrowhead), findings characteristic of a second branchial cleft cyst.

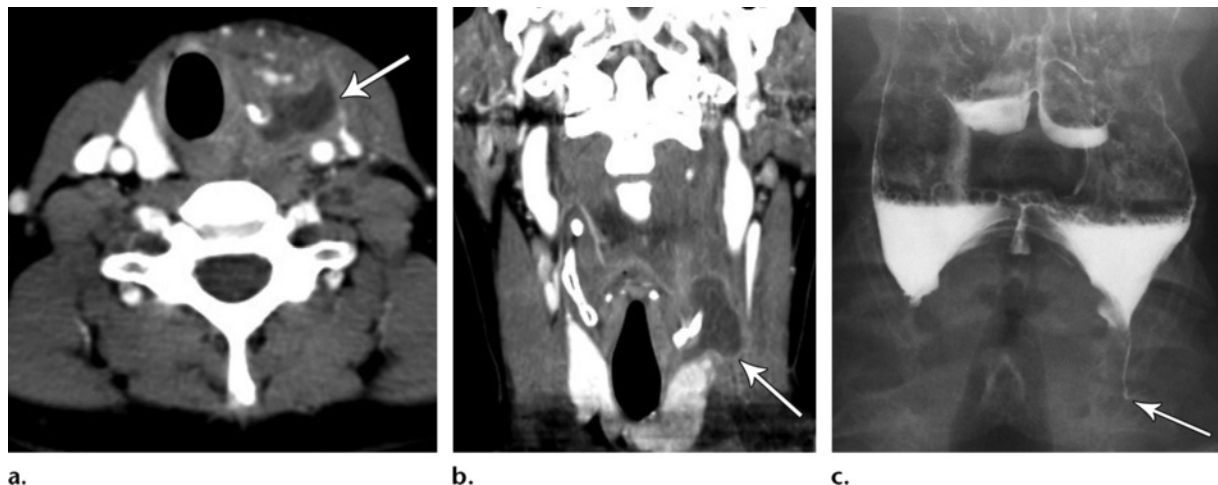
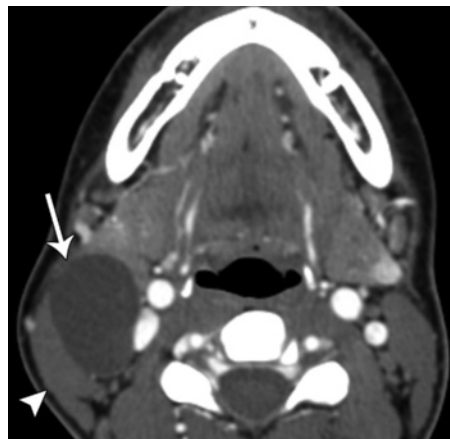
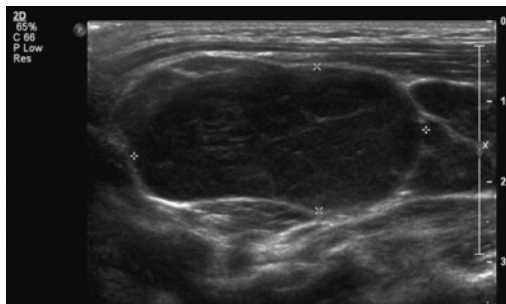


Figure 20. Third or fourth branchial anomaly with pyriform sinus fistula in a 19-year-old woman with recurrent left neck abscesses. **(a, b)** Axial **(a)** and coronal **(b)** contrast-enhanced CT images show a peripherally enhancing fluid collection at the superior pole of the left thyroid lobe (arrow), a finding suggestive of an abscess. **(c)** Frontal radiograph obtained at a barium swallow examination 2 weeks after a course of antibiotic treatment depicts a fistula (arrow) that arises from the left pyriform sinus.



a.
Figure 21. Reactive hyperplastic cervical lymph node in a 4-year-old boy with a palpable neck mass. **(a)** Longitudinal US image shows an enlarged hypoechoic nodal mass. **(b)** Axial contrast-enhanced CT image shows a unilateral enlarged right posterior triangle lymph node (arrow). Follow-up US depicted resolution of the nodal mass, a typical outcome of reactive lymphadenopathy.



b.

The Sistrunk procedure, the standard method of management, includes surgical resection of the cyst, the central portion of the hyoid bone, and the thyroglossal duct to the level of the foramen cecum (30).

Branchial Cleft Cysts

The most common branchial cleft abnormality is the second branchial cleft cyst. This is typically recognized in patients 10–40 years of age, with the classic location anteromedial to the sternocleidomastoid muscle, anterolateral to the carotid arteries, and posterior to the submandibular gland (30). Cysts are often recognized secondary to swelling, but they may manifest as a painful, fluctuant mass when infected.

US, CT, and MR imaging all demonstrate cystic lesions in the appropriate anatomic location (Fig 19). Surgical resection is the standard treatment (30).

First branchial cleft cysts are closely related to the parotid gland and typically extend into the external auditory canal. They most often are found in middle-aged women who present with recurrent abscesses near the ear or angle of the mandible. Imaging demonstrates a cystic lesion associated with the parotid gland, a finding that is difficult to differentiate from other parotid lesions on the basis of imaging alone (30).

Third and fourth branchial anomalies are rare and difficult to distinguish from one another but should be considered in the presence of a cervical or thyroid abscess. Third and fourth branchial anomalies most commonly occur on the left side and often are associated with a fistulous tract to the pyriform sinus. A barium swallow study with or without subsequent neck CT is useful in demonstrating such a fistula after the acute infection resolves (Fig 20). The communication to the pyriform sinus also may be directly visualized (32). The main differential consideration is thyroid malignancy. Antibiotic therapy and resection or thyroidectomy are the preferred methods of treatment (33).

Cervical Lymphadenopathy

Enlargement of cervical lymph nodes may be due to infectious, inflammatory, neoplastic, or idiopathic causes. Enlarged cervical nodes are the most common neck masses in children (30).

Normal lymph nodes are classified according to diameter, which is generally less than 10 mm in the long axis. Exceptions are level IB and

level IIA nodes, which may be as large as 15 mm in diameter, and retropharyngeal nodes, which should not exceed 8 mm (34). Normal nodes are iso- or hypoattenuating to muscle on CT images and have a shape similar to that of a lima bean. On T1-weighted MR images, nodes have low to intermediate signal intensity, and on T2-weighted images, they have intermediate to high signal intensity (34). On US images, normal nodes appear hypoechoic in comparison with muscle. They have an ovoid shape and an echogenic fatty hilum (35).

Imaging findings of cervical lymphadenopathy are often nonspecific, although the size, enhancement, and distribution of nodes, and associated head and neck findings, may be suggestive of an underlying cause.

Patients with benign, reactive lymph nodes typically present with signs of local or systemic infection, with painful, mobile nodes at physical examination. At imaging, these nodes are normal to slightly enlarged in size, and they may enhance or demonstrate increased vascularity at US (Fig 21). Bacterial infections tend to produce greater enlargement of nodes with inflammatory change in surrounding tissues, and they may progress to suppurative adenopathy (34). Viral infections produce diffuse lymph node involvement, with little surrounding inflammation. Common viral causes include cytomegalovirus, infectious mononucleosis, and human immunodeficiency virus. Lymph node enlargement also may be secondary to inflammatory causes such as sarcoidosis or may be idiopathic, as in the Kimura, Kawasaki, and Kikuchi-Fujimoto diseases.

Suppurative lymph nodes are hypoattenuating, with rimlike enhancement and inflammatory change in adjacent structures on CT images. MR imaging findings include central signal hyperintensity on T2-weighted images and hypointensity on T1-weighted images, with peripheral enhancement on contrast-enhanced T1-weighted images. Intranodal cystic components and vascularity are commonly seen on US images (35). There are many possible bacterial causes of suppurative lymph nodes, but the distribution of these findings may aid in narrowing the differential diagnosis. For example, the presence of suppurative adenopathy involving level V lymph nodes is suggestive of tuberculous adenitis (Fig 22).

Firm, nonmobile, painless cervical lymph nodes raise concern for neoplastic involvement. Neoplastic nodes demonstrate variable imaging characteristics and may be secondary to Castleman disease, lymphoma (both Hodgkin and non-Hodgkin), leukemia, or metastases. At CT, lymph nodes involved in malignancy (particularly metastatic disease) may have an appearance of central hypoattenuation secondary to necrosis with irregular peripheral enhancement (Fig 23). Ill-defined borders and loss of fat planes between nodes and adjacent structures (muscle, vasculature, bone) are suggestive of extracapsular spread of malignancy. At US, the affected nodes also show a loss of echogenicity in the hilum, peripheral or mixed hypervascularity on Doppler images, and possibly, intranodal cystic change (35). Although metastatic disease is rare in children and young adults, it is critical to consider the possibility of metastasis from papillary thyroid cancer in a young female, squamous cell carcinoma in young adults, and neuroblastoma and rhabdomyosarcoma in children.

Retropharyngeal (Prevertebral) Abscess

Retropharyngeal abscesses result from spread of infection from retropharyngeal lymph nodes, which drain the middle ear, sinuses, and upper respiratory tract. Such abscesses are more common in children younger than 6 years, as the retropharyngeal nodes atrophy with age. Other possible causes of retropharyngeal abscesses include trauma from foreign body ingestion and iatrogenic injury secondary to intervention (14). Because of the possibility of life-threatening complications due to airway compromise and spread of infection to the mediastinum, the recognition of these abscesses is important.

The retropharyngeal space is a potential space between the prevertebral and visceral spaces, between the middle and deep layers of the deep cervical fascia. The space is not well depicted at imaging unless a pathologic process is present (14). In the presence of an infection or other disease process, the retropharyngeal space appears as a bow tie-shaped structure bordered by the pharynx anteriorly, the prevertebral muscles posteriorly, and the internal carotid arteries bilaterally.



Figure 22. Tuberculous adenitis in a 12-year-old boy with a palpable neck mass. Coronal contrast-enhanced CT image demonstrates suppurative adenopathy involving multiple level V lymph nodes in the right side of the neck. Aspirate obtained with a fine-needle biopsy contained acid-fast bacilli.



Figure 23. Nodal metastasis in a 20-year-old man with a left-sided neck mass. Axial contrast-enhanced CT image depicts a large left jugulodigastric lymph node with internal necrosis and irregular peripheral enhancement. Squamous cell carcinoma was found at nodal biopsy, and a primary tongue neoplasm was subsequently identified.

The clinical manifestations are variable. However, a fever, neck pain, sore throat, and cough are common (36).

Lateral neck radiographs demonstrate prevertebral or retropharyngeal soft tissue thickening (Fig 24a). Another common feature is gas within the prevertebral soft tissues. The radiologist should be alert for the interpretive pitfall of soft

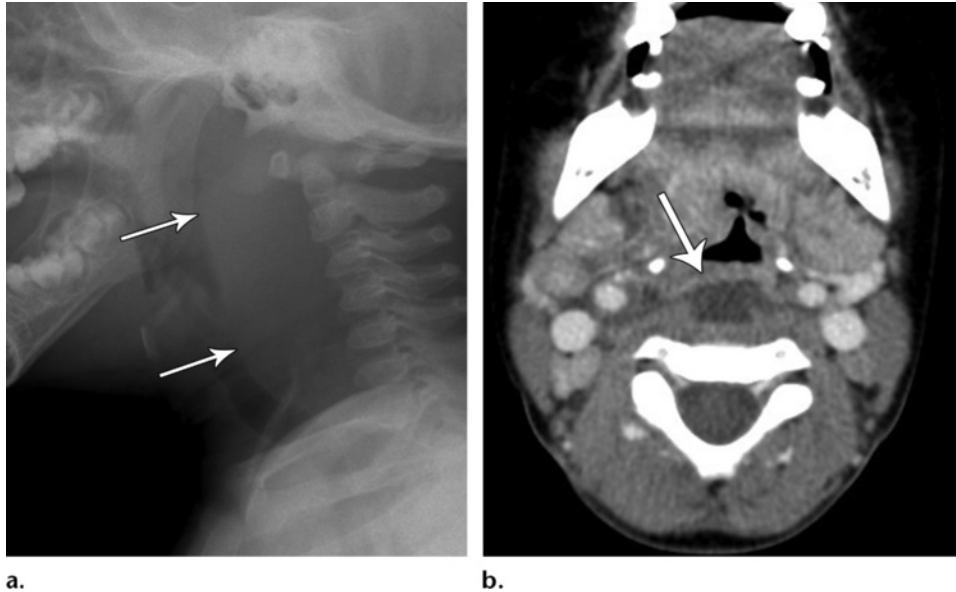


Figure 24. Retropharyngeal abscess in a 3-year-old girl with fever and throat pain. (a) Lateral neck radiograph shows diffuse prevertebral soft tissue swelling (arrows). (b) Axial contrast-enhanced CT image demonstrates a mildly enhancing, thick-walled retropharyngeal fluid collection (arrow). These findings are indicative of an abscess.



Figure 25. Suppurative lateral retropharyngeal node in an 11-month-old girl with left-sided neck swelling. Axial contrast-enhanced CT image depicts a peripherally enhancing fluid collection (arrow) in a location medial to the left internal carotid artery, a finding suggestive of an abscess within the lateral retropharyngeal node.

tissue “pseudothickening,” which results from neck flexion or incomplete inspiration and is especially common in pediatric patients (27). If the quality of radiographic images is inadequate, the radiographic examination should be repeated or airway fluoroscopy should be performed.

On CT and MR images, characteristic findings include fluid within the retropharyngeal space, with peripheral rimlike enhancement after contrast material administration (Fig 24b).

The differentiation of abscesses from retropharyngeal edema or cellulitis is critical but difficult in the absence of rimlike enhancement. It is also important to differentiate retropharyngeal abscesses from suppurative retropharyngeal lymph nodes (Fig 25).

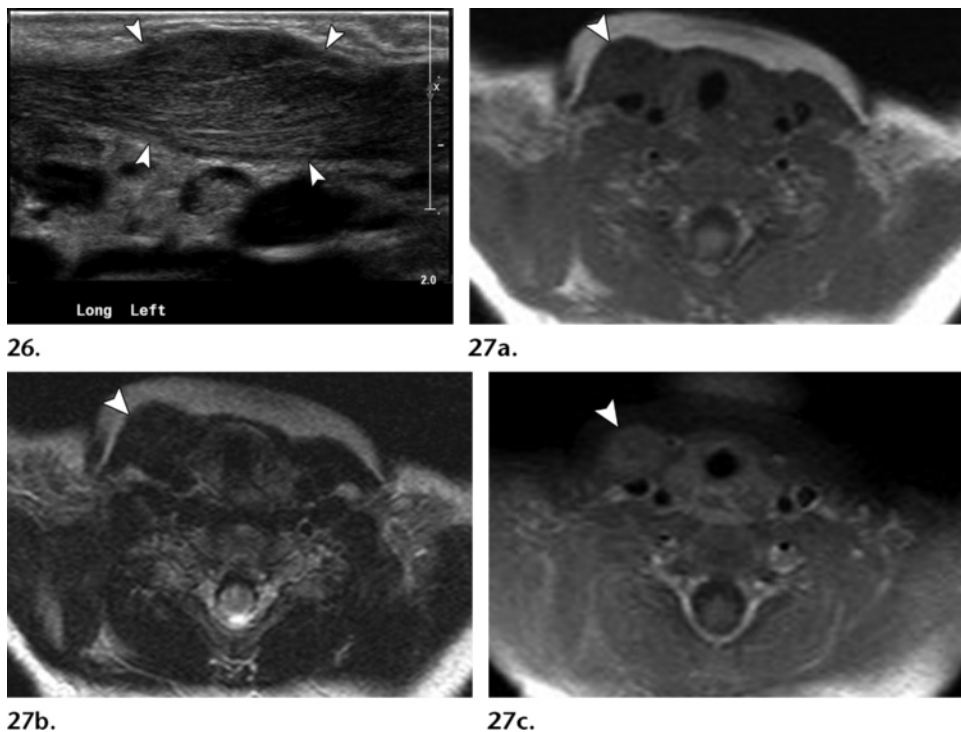
Possible complications include mediastinitis, necrotizing cervical infection, internal jugular vein thrombosis, carotid artery involvement, and aspiration of pus with pneumonia or empyema (14).

Retropharyngeal cellulitis and small retropharyngeal abscesses typically are treated with intravenous antibiotics. Larger abscesses are treated with incision and drainage (14).

Fibromatosis Colli

Fibromatosis colli, or pseudotumor of the sternocleidomastoid muscle, is a benign self-limiting

Teaching
Point



Figures 26, 27. Fibromatosis colli. (26) Gray-scale US image obtained in a 1-month-old girl with a right-sided neck mass demonstrates a focal, fusiform area of thickening in the sternocleidomastoid muscle (arrowheads). (27) Axial MR images obtained in another infant demonstrate asymmetric enlargement of the right sternocleidomastoid muscle (arrowhead). The enlarged region has signal characteristics of mild hypointensity on the T1-weighted image (a), mild hyperintensity on the T2-weighted image (b), and mild enhancement on the contrast-enhanced T1-weighted fat-suppressed image (c).

condition that may occur in infants within the first 2–4 weeks of life. It is thought to result from fibrocollagenous infiltration of the sternocleidomastoid muscle (37) and is often associated with breech or forceps deliveries (24). Patients typically present with a unilateral firm and nontender mass within the mid to lower sternocleidomastoid muscle. Torticollis is seen in an estimated 20% of cases (37).

US is the most appropriate modality for the initial imaging assessment. Characteristic US findings include focal or diffuse enlargement of the sternocleidomastoid muscle, which has variable echogenicity (38) (Fig 26). CT and MR images depict focal or diffuse enlargement of the muscle, without extramuscular extension or associated soft tissue abnormalities. MR signal characteristics include isointensity on T1-weighted images and slight hyperintensity relative to muscle on T2-weighted images, with heterogeneous enhancement after contrast material administration (Fig 27). Although the latter feature may simulate a neoplasm, the clinical manifestations and US findings aid in the diagnosis. Fibromatosis colli usually resolves spontaneously within the

1st year of life. Rarely, tenotomy may be required to treat associated torticollis (24).

Conclusions

Imaging plays a critical role in the diagnosis of pediatric head and neck conditions in the emergency setting, as well as in detecting any associated life-threatening complications. Because a wide range of pathologic processes may produce similar symptoms and lead to similar complications, familiarity with the imaging manifestations that allow differentiation between these entities is crucial. Radiologists must also be able to identify common congenital lesions and recognize associated complications. The specific imaging protocol depends on the patient's clinical status; however, radiography, US, and contrast-enhanced CT are appropriate first-line modalities, and MR imaging may provide additional detail with respect to the extent of disease.

References

1. Mafee MF. Orbit: embryology, anatomy, and pathology. In: Som PM, Curtin HD, eds. *Head and neck imaging*. 4th ed. St. Louis, Mo: Mosby, 2003; 529–654.
2. LeBedis CA, Sakai O. Nontraumatic orbital conditions: diagnosis with CT and MR imaging in the emergent setting. *RadioGraphics* 2008;28(6): 1741–1753.

3. Eustis HS, Mafee MF, Walton C, Mondonca J. MR imaging and CT of orbital infections and complications in acute rhinosinusitis. *Radiol Clin North Am* 1998;36(6):1165–1183.
4. Fakhri S, Pereira K. Endoscopic management of orbital abscesses. *Otolaryngol Clin North Am* 2006;39(5):1037–1047.
5. Kassel EE, Schatz CJ. Lacrimal apparatus. In: Som PM, Curtin HD, eds. *Head and neck imaging*. 4th ed. St. Louis, Mo: Mosby, 2003; 655–733.
6. Kronemer KA, McAlister WH. Sinusitis and its imaging in the pediatric population. *Pediatr Radiol* 1997;27(11):837–846.
7. American College of Radiology. ACR Appropriateness Criteria: sinusitis—child. American College of Radiology Web site. http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria/pdf/ExpertPanelonPediatricImaging/SinusitisChildDoc8.aspx. Revised 2009. Accessed March 26, 2010.
8. Epstein VA, Kern RC. Invasive fungal sinusitis and complications of rhinosinusitis. *Otolaryngol Clin North Am* 2008;41(3):497–524.
9. Morón FE, Morriss MC, Jones JJ, Hunter JV. Lumps and bumps on the head in children: use of CT and MR imaging in solving the clinical diagnostic dilemma. *RadioGraphics* 2004;24(6):1655–1674.
10. Khanna G, Sato Y, Smith RJ, Bauman NM, Nerad J. Causes of facial swelling in pediatric patients: correlation of clinical and radiologic findings. *RadioGraphics* 2006;26(1):157–171.
11. Department of Health and Human Services. Guide to children's dental care in Medicaid. <http://www.cms.hhs.gov/medicaidcoverage/downloads/dentalguide.pdf>. Published October 2004. Accessed February 26, 2009.
12. Ladrillo TE, Hobdell MH, Caviness AC. Increasing prevalence of emergency department visits for pediatric dental care, 1997–2001. *J Am Dent Assoc* 2006;137(3):379–385.
13. Dunfee BL, Sakai O, Pistey R, Gohel A. Radiologic and pathologic characteristics of benign and malignant lesions of the mandible. *RadioGraphics* 2006;26(6):1751–1768.
14. Vieira F, Allen SM, Stocks RM, Thompson JW. Deep neck infection. *Otolaryngol Clin North Am* 2008;41(3):459–483.
15. Marcus BJ, Kaplan J, Collins KA. A case of Ludwig angina: a case report and review of the literature. *Am J Forensic Med Pathol* 2008;29(3):255–259.
16. Smoker WRK. The oral cavity. In: Som PM, Curtin HD, eds. *Head and neck imaging*. 4th ed. St. Louis, Mo: Mosby, 2003; 1377–1464.
17. Britt JC, Josephson GD, Gross CW. Ludwig's angina in the pediatric population: report of a case and review of the literature. *Int J Pediatr Otorhinolaryngol* 2000;52(1):79–87.
18. Laine FJ, Nadel L, Braun IF. CT and MR imaging of the central skull base. II. Pathologic spectrum. *RadioGraphics* 1990;10(5):797–821.
19. Robson C, Hudgins P. Pediatric airway disease. In: Som PM, Curtin HD, eds. *Head and neck imaging*. 4th ed. St. Louis, Mo: Mosby, 2003; 1521–1594.
20. Danesi G, Panciera DT, Harvey RJ, Agostinis C. Juvenile nasopharyngeal angiofibroma: evaluation and surgical management of advanced disease. *Otolaryngol Head Neck Surg* 2008;138(5):581–586.
21. Wiatrak BJ, Koopmann CF, Turrisi AT. Radiation therapy as an alternative to surgery in the management of intracranial juvenile nasopharyngeal angiofibroma. *Int J Pediatr Otorhinolaryngol* 1993;28(1):51–61.
22. Vazquez E, Castellote A, Piqueras J, et al. Imaging of complications of acute mastoiditis in children. *RadioGraphics* 2003;23(2):359–372.
23. Grandis JR, Curtin HD, Yu VL. Necrotizing (malignant) external otitis: prospective comparison of CT and MR imaging in diagnosis and follow-up. *Radiology* 1995;196(2):499–504.
24. Wiggins R. Necrotizing external otitis. In: Harnsberger R, Hudgins P, Wiggins R, et al, eds. *Diagnostic imaging: head and neck*. Salt Lake City, Utah: Amirsys, 2004; 10–13.
25. Carfrae MJ, Kesser BW. Malignant otitis externa. *Otolaryngol Clin North Am* 2008;41(3):537–549.
26. Sobol SE, Zapata S. Epiglottitis and croup. *Otolaryngol Clin North Am* 2008;41(3):551–566.
27. Donnelly LF. Airway. In: Donnelly LF, ed. *Pediatric imaging: the fundamentals*. Philadelphia, Pa: Saunders, 2009; 8–25.
28. Digoy GP. Diagnosis and management of upper aerodigestive tract foreign bodies. *Otolaryngol Clin North Am* 2008;41(3):485–496.
29. Herzon FS. Peritonsillar abscess: incidence, current management practices, and a proposal for treatment guidelines. Harris P. Mosher Award thesis. *Laryngoscope* 1995;105(8 pt 3 suppl 74):1–17.
30. Koeller KK, Alamo L, Adair CF, Smirniotopoulos JG. Congenital cystic masses of the neck: radiologic-pathologic correlation. *RadioGraphics* 1999;19(1):121–146.
31. Kutuya N, Kurosaki Y. Sonographic assessment of thyroglossal duct cysts in children. *J Ultrasound Med* 2008;27(8):1211–1219.
32. Thomas B, Shroff M, Forte S, et al. Revisiting imaging features and the embryologic basis of third and fourth branchial anomalies. *Am J Neuroradiol*. doi: 10.3174/ajnr.A1902. Published December 10, 2009. Accessed March 28, 2010.
33. Park SW, Han MH, Sung MH, et al. Neck infection associated with pyriform sinus fistula: imaging findings. *AJNR Am J Neuroradiol* 2000;21(5):817–822.
34. Sakai O, Curtin HD, Romo LV, Som PM. Lymph node pathology: benign proliferative, lymphoma, and metastatic disease. *Radiol Clin North Am* 2000;38(5):979–998, x.
35. Ahuja AT, Ying M. Sonographic evaluation of cervical lymph nodes. *AJR Am J Roentgenol* 2005;184(5):1691–1699.
36. Craig FW, Schunk JE. Retropharyngeal abscess in children: clinical presentation, utility of imaging, and current management. *Pediatrics* 2003;111(6 pt 1):1394–1398.
37. Delman BN, Weissman JL, Som PM. Skin and soft-tissue lesions. In: Som PM, Curtin HD, eds. *Head and neck imaging*. 4th ed. St. Louis, Mo: Mosby, 2003; 2173–2215.
38. Barkovich AJ. Intracranial, orbital, and neck masses of childhood. In: Barkovich AJ, ed. *Pediatric neuroimaging*. 4th ed. Philadelphia, Pa: Lippincott, Williams, and Wilkins, 2005; 506–658.

Diagnostic Imaging in Nontraumatic Pediatric Head and Neck Emergencies

Benjamin J. Ludwig, MD • Bryan R. Foster, MD • Naoko Saito, MD Rohini N. Nadgir, MD • Ilse Castro-Aragon, MD • Osamu Sakai, MD, PhD

RadioGraphics 2010; 30:781–799 • Published online 10.1148/rg.303095156 • Content Codes: ER HN NR PD

Page 782

Periorbital (preseptal) and orbital (postseptal) cellulitis are differentiated by their location with respect to the orbital septum. Their accurate characterization determines the aggressiveness of management, with the preservation of vision being of primary concern.

Page 784

Although CT and MR imaging lack specificity for the diagnosis of acute sinusitis, either modality may be appropriately used to identify sinusitis-related complications.

Page 790

In pediatric patients in whom croup is suspected, imaging is performed to determine whether another cause of inspiratory stridor is present that may require emergent intervention (such causes might include epiglottitis and foreign body ingestion).

Page 793

It is critical to identify common congenital lesions, such as branchial cleft cysts and thyroglossal duct cysts, and to recognize their complications, which may include superinfection.

Page 797

The differentiation of abscesses from retropharyngeal edema or cellulitis is critical but difficult in the absence of rimlike enhancement.