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Emergency Imaging of the Nontraumatic Pediatric Head and Neck

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Pediatric patients present emergently with a wide variety of infectious, inflammatory, congenital, traumatic, and neoplastic conditions. Imaging plays a crucial role in distinguishing among the potential diagnoses, as often, history and physical exam is limited in these young sick patients. Understanding the imaging appearance of the range of conditions which are commonly encountered and their potential complications, facilitates appropriate and expedient management. The radiologist must recognize the benefits of the various imaging modalities available and help the clinician choose among the possibilities depending on the clinical status of the patient.
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Introduction

Nontraumatic emergencies constitute a large proportion of visits to the emergency room, urgent care, and clinics every year. In children, the most frequently encountered conditions often have similar clinical presentations making imaging very important to arrive at the correct diagnosis. The radiologist must be familiar with the appearance of a spectrum of congenital, neoplastic, infectious, and inflammatory conditions in the head and neck to be able to integrate the radiologic findings with the clinical presentation.

A variety of imaging modalities are available in the emergency setting including radiography, ultrasound (US), computed tomography (CT), and now also magnetic resonance imaging (MRI) in many institutions. Based on the presenting condition of the patient, each of these may be an appropriate choice. Imaging of children has undergone significant change in the last decade.[1] While the growing uses for MRI and concern over medical radiation have certainly affected how we image children today, there is still a very important role for CT and radiography which remain several of the modalities of choice in the emergency setting. These modalities, in additional to US, can provide fast imaging often without the need for sedation, making them the most frequently used tools for evaluating critically ill patients with suspected head and neck pathology. Additionally, for patients who cannot undergo MRI secondary to implanted devices or external monitoring hardware, radiography, US, and CT still remain available. MRI is most often reserved for assessment of complications associated with certain head and neck illnesses rather than used as a first line imaging tool. Given the variety of imaging options available today, the American College of Radiology (ACR) has published standards and guidelines designed to aid in selecting the most appropriate imaging modality for various clinical presentations in children.[2]

This review discusses the important imaging findings in the most commonly encountered pediatric nontraumatic head and neck emergencies with a focus on how these conditions differ in children from adults. It also highlights the appropriate imaging modalities used in diagnosing the various conditions.

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Child With a Red Swollen Eye

Preseptal and Postseptal Cellulitis

When a child presents with a red and swollen eye, one of the primary considerations is orbital cellulitis. It is important to distinguish between pre- and postseptal cellulitis as management differs significantly. In periorbital or preseptal cellulitis, the inflammation is confined to the structures that lie anterior to the orbital septum, a thin fibrous sheet that runs from the orbital rim to the tarsal plates and lid. The inflammation therefore frequently involves the lid, cheek, and skin around the orbit and is typically secondary to local skin or soft tissue trauma such as from a bug bite or from spread of adjacent

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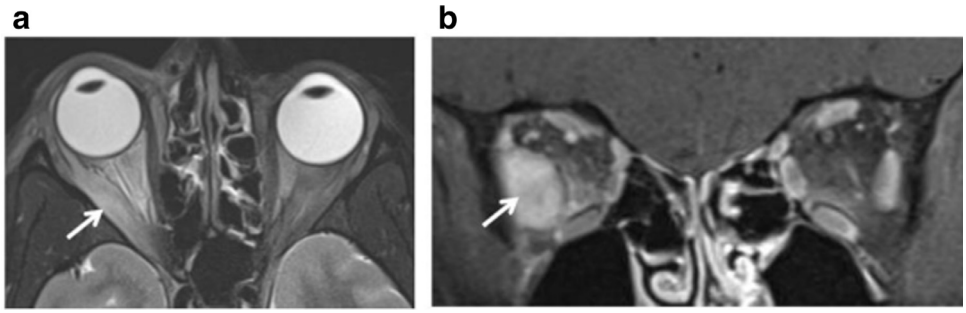

Figure 1 (a) Axial fat saturated T2-weighted image and (b) coronal fat saturated postcontrast T1-weighted image in a patient with idiopathic orbital inflammatory disease demonstrating edema, enhancement, and enlargement of the right lateral rectus muscle (arrows), edema within the right greater than left intraconal fat, and right globe proptosis. The paranasal sinuses demonstrate only minimal mucosal thickening without sinusitis.

infection.[3] Management of nontoxic appearing children over the age of 1 year is frequently conservative with outpatient oral antibiotics as long as there is good follow up arranged.[4] In orbital or postseptal cellulitis however, the infection involves the deeper postseptal structures which can be further divided into the intraconal and extraconal locations based upon the relationship to the extraocular muscles. The intraconal orbit includes the extraocular muscles, retrobulbar fat and optic nerve sheath complex; while the extraconal orbit is comprised by fat, the lacrimal glands, and vascular structures. In children, orbital cellulitis is most commonly secondary to sinusitis, to such a degree that if you encounter orbital inflammation in the absence of sinusitis, you should strongly consider alternate differential diagnoses such as idiopathic orbital inflammatory disease (IOID) (Fig. 1).

CT with IV contrast is the imaging modality of choice for evaluating patients with orbital inflammation to determine the compartments involved. In orbital cellulitis, findings will frequently include sinus disease, extraconal subperiosteal fluid collections with or without rim enhancement adjacent to the involved sinuses, enlargement of the adjacent extraocular muscles, stranding in the retrobulbar fat, and proptosis (Fig. 2). CT with contrast allows one to look for additional complications of sinusitis and orbital cellulitis including ophthalmic vein and cavernous sinus thrombosis, epidural abscess, and subdural empyema, though MRI with contrast may also be utilized for this purpose (Fig. 2). Orbital cellulitis is treated with IV antibiotics and may also require surgical drainage of associated abscesses.[5]

Dacryocystitis

In children presenting with more focal swelling involving the medial canthus and lid, dacryocystitis should be considered. The diagnosis is often made clinically without the need for imaging though certain patients may present with more global lid and periorbital swelling necessitating a more broad consideration of diagnoses. Pediatric dacryocystitis differs from adult disease in that it more frequently results from a complication of congenital nasolacrimal duct obstruction, may be associated with dacryocele in neonates and infants, and can have a more rapidly progressive course to a lacrimal abscess (Fig. 3).[6] If there is concern for an abscess, CT with IV contrast is the modality of choice for assessment with management differing based on the presence of an underlying congenital lesion or abscess requiring surgical intervention, or inflammation in the absence of these findings which can be treated with antibiotics.

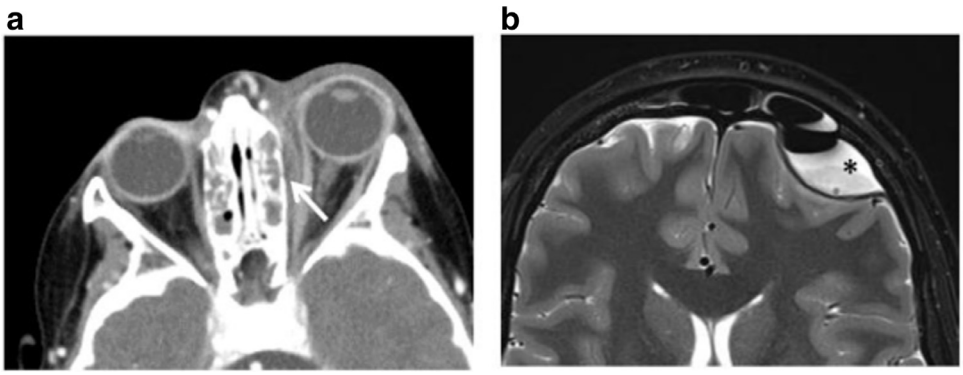

Figure 2 (a) Axial contrast-enhanced CT demonstrating ethmoid sinusitis and a subperiosteal abscess along the medial left extraconal orbit (arrow) resulting in left proptosis. There is inflammation within both the preseptal and postseptal left orbit. (b) Axial fat saturated T2-weighted MRI image of the brain demonstrating an epidural abscess (*) along the left frontal lobe subjacent to left frontal sinusitis.

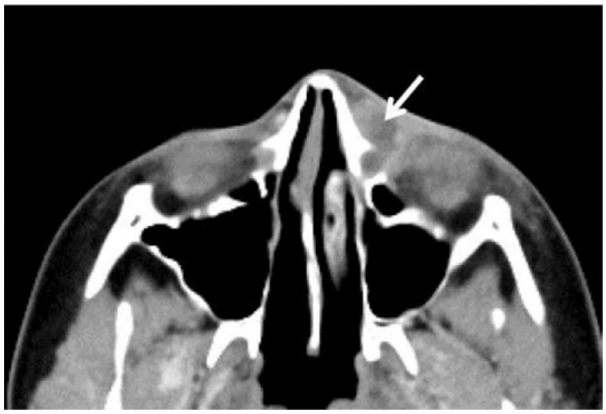

Figure 3 Axial contrast-enhanced CT demonstrating a small rim enhancing fluid collection and surrounding inflammation along the medial left orbit associated with the nasolacrimal duct (arrow) consistent with an abscess in the setting of dacryocystitis.

Orbital Wall Infarct

Patients with sickle cell disease (SCD) may present with a unique complication in the setting of vaso-occlusive crisis leading to orbital inflammation that should be kept in mind in this population. Orbital wall infarction (OWI) while rare, occurs more frequently in children with SCD than adults due to their larger active marrow spaces.[7] The clinical and imaging features of OWI overlap with those of orbital cellulitis, osteomyelitis, and IOID making the diagnoses further challenging.[8] Unlike in orbital cellulitis, significant paranasal sinus disease is uncommon in OWI. In both OWI and IOID there may be significant swelling of the lacrimal gland, though in OWI, edema within the extraocular muscles is rare and much more commonly encountered in IOID. In patients with SCD and OWI, typical findings include sclerosis of the involved orbital bone, subperiosteal collections along the lateral orbital wall and in the infratemporal fossa posterior to the zygoma (Fig. 4) features which would be extremely atypical in orbital cellulitis and IOID. CT with IV contrast is the modality of choice for evaluating these patients and ancillary nuclear medicine scans may be needed in select patients to distinguish OWI from osteomyelitis. Management with analgesia and IV fluids are central, with drainage of subperiosteal hematomas occasionally necessary when they encroach on the orbit. Red blood cell transfusion and steroids are reserved for severe cases.[7,8]

Child With a Sore Throat and Fever

Tonsillitis/Tonsillar Abscess

Pharyngitis is one of the leading causes of pediatric ambulatory care visits accounting for approximately 1.8% of all outpatient visits in adults and children.[9] Untreated, these infections can progress to serious complications including peritonsillar/tonsillar abscesses (PTA), retropharyngeal abscesses, and acute rheumatic fever among others.[10] The majority of adenotonsillar complaints in children do not require imaging, with physical exam and direct inspection via nasopharyngoscopy and laryngoscopy providing adequate information in decision making. Intraoral ultrasound can be performed in older cooperative children to confirm or exclude a suspected PTA and CT with intravenous contrast should be reserved for select children to evaluate for deep extension of a PTA, in patients suspected of having a tonsillar neoplasm or in patients with trismus or difficulty cooperating where direct inspection is limited.[11,12]

On imaging, infection with a variety of bacterial and viral pathogens can present with enlarged adenoids and tonsils often with a striated pattern of enhancement (Fig. 5). When the infection has progressed to a PTA, there will be a rim enhancing fluid collection centered within or adjacent to one of the tonsils with surrounding stranding and fluid in the parapharyngeal fat and effacement of the airway (Fig. 5).

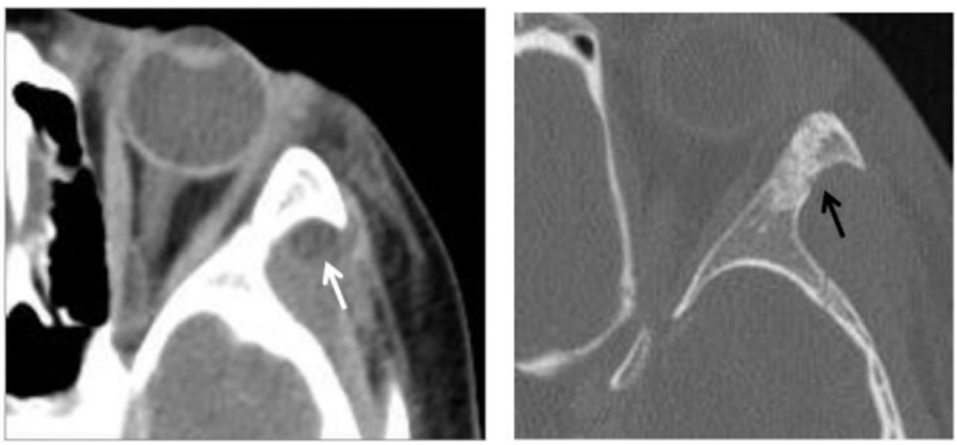

Figure 4 Axial contrast-enhanced CT in soft tissue and bone windows. There is a small retrozygomatic fluid collection (white arrow) and mild stranding within the lateral periorbital soft tissues. There is sclerosis of the lateral orbital rim and sphenoid bone (black arrow). The patient has sickle cell disease (SCD), presented with vaso-occlusive crisis and the fluid collection was found to be sterile hematoma at the time of drainage in the setting of an orbital wall infarct.

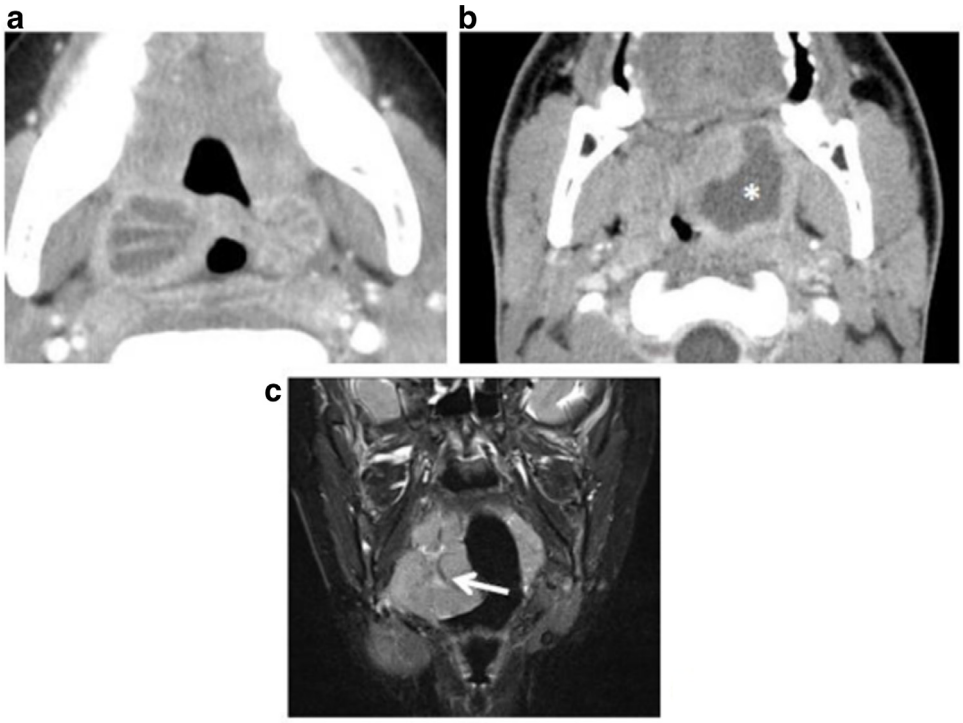

Figure 5 Axial contrast-enhanced CTs of the face in two different patients. (a) There is enlargement and striated enhancement of both palatine tonsils consistent with tonsillitis. (b) There is a focal rim enhancing fluid collection centered within the enlarged left tonsil (*) consistent with a tonsillar abscess and resultant partial effacement of the airway. (c) Coronal fast spin-echo inversion recovery magnetic resonance imaging (FSEIR MRI) image demonstrates marked asymmetry, enlargement and irregular morphology of the right palatine tonsil (arrow) in a child proven to have Burkitt lymphoma at pathology.

Additional diseases can present with enlarged tonsils in children and familiarity is important to guide management. The tonsils in adolescents with mononucleosis are typically symmetric and markedly enlarged with effacement of the posterior nasal cavity and nasopharynx in association with cervical adenopathy. When the tonsil is either asymmetrically enlarged or very irregular in morphology, especially in the setting of asymmetric cervical adenopathy, one should also consider the possibility of a neoplasm such as lymphoma and advise histologic sampling (Fig. 5).[13,14]

Retropharyngeal Abscess

The incidence of retropharyngeal abscesses (RPA) is increasing in the US, occurring most commonly in young children less than 5 years of age. It is thought to arise from suppuration of retropharyngeal lymph nodes and subsequent abscess formation and can lead to serious complications including airway obstruction and mediastinitis.[15] Imaging may start with a lateral radiograph of the neck to evaluate for pre vertebral soft tissue swelling and possibly soft tissue gas, though given difficulties in appropriate neck positioning and inspiratory effort, as well as inability to distinguish RPA from phlegmon or adenopathy on radiography; imaging with contrast-enhanced CT is preferred.[16] CT can identify the extent of the fluid collection and effect on the airway. CT can also help to differentiate RPA from contained suppurative retropharyngeal adenopathy which will demonstrate maintenance of the normal nodal architecture with smaller size of internal fluid, be located laterally rather than across the midline, and can often be managed more conservatively with antibiotics (Fig. 6).[17] CT permits assessment for vascular complications including jugular vein thrombosis, reactive narrowing of the internal carotid artery, and rarely encountered pseudo aneurysms. Early consultation with otolaryngology is advised in cases of suspected RPA to ensure appropriate airway management with ultimate treatment including IV antibiotics and surgical drainage in selected cases.[17]

Epiglottitis/Supraglottitis

Since the Hemophilus influenza type B (Hib) vaccine was added to the immunization schedule, the incidence of epiglottitis in children has fallen in the US with the age range of those affected now also being slightly older than in the past.[18,19] Epiglottitis can result from a variety of viral and bacterial pathogens and lead to acute onset of severe distress including drooling, dysphagia, sore throat, and stridor secondary to marked swelling of the supraglottis and resultant airway effacement. Prompt recognition and airway management is imperative and imaging is only reserved for those children deemed stable enough to tolerate it with a lateral neck radiograph being the modality of choice. On radiography, there will be thickening of the epiglottis and aryepiglottic folds with distension of the aerated hypopharynx (Fig. 7). CT neck with contrast is not routinely performed and should only be

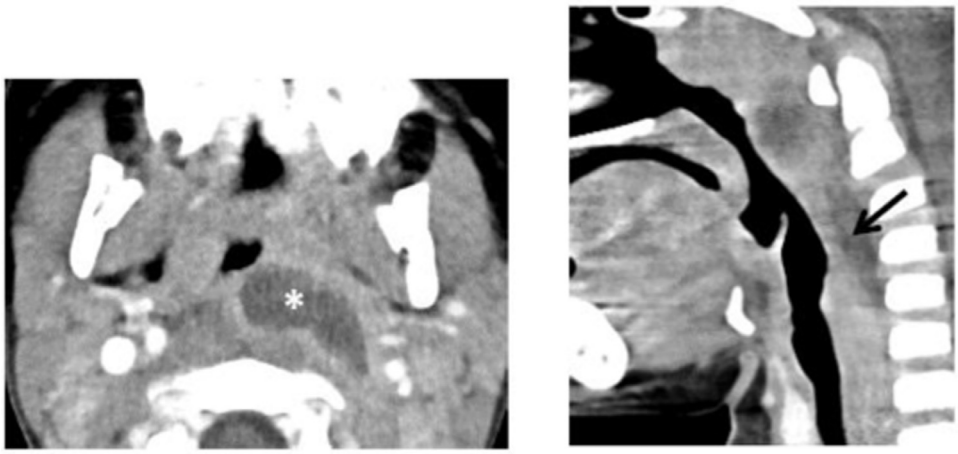

Figure 6 Axial and sagittal contrast enhanced CT images demonstrating a rim enhancing fluid collection centered within the left lateral retropharyngeal space extending across the midline with loss of the normal nodal architecture (*). There is extension of fluid inferiorly to the mid cervical neck within the retropharyngeal space (arrow).

considered in stable patients with a protected airway when a noninfectious cause of epiglottic edema is suspected such as from foreign body aspiration, caustic ingestion, granulomatosis diseases or an epiglottic cyst.[20]

Child with Epistaxis

Juvenile Nasopharyngeal Angiofibroma

Epistaxis while rarely life-threatening, is a frequent cause of visits to the pediatric urgent care and emergency room. Most children will require nothing more than direct compression of the nasal alae to stop the bleeding; however, when it is recurrent, recalcitrant or results in airway or circulatory compromise, then further investigation is warranted. After consultation with otolaryngology, if there is concern for a mass on nasal endoscopy, then imaging with either contrast enhanced CT or MRI can be performed. In adolescent males, juvenile nasopharyngeal angiofibroma (JNA) should be considered when a patient presents with symptoms of nasal obstruction and recurrent epistaxis. While benign, these tumors are very aggressive and can grow to large sizes filling the nasopharynx, nasal cavity, sinuses, and extending intracranially or into the masticator space, which is best assessed on MRI. On imaging, JNAs are centered in the sphenopalatine foramen, widen the pterygopalatine fossa and are locally destructive causing both bony expansion and erosion of the walls of the sinuses and nasal cavity (Fig. 8).[21] On both CT and MRI, these masses demonstrate avid enhancement and on MRI, one may additionally see prominent vascular flow voids (Fig. 8). Catheter angiography is useful in the workup of these tumors allowing for direct visualization of the feeding vessels and for preoperative embolization in select cases.[22]

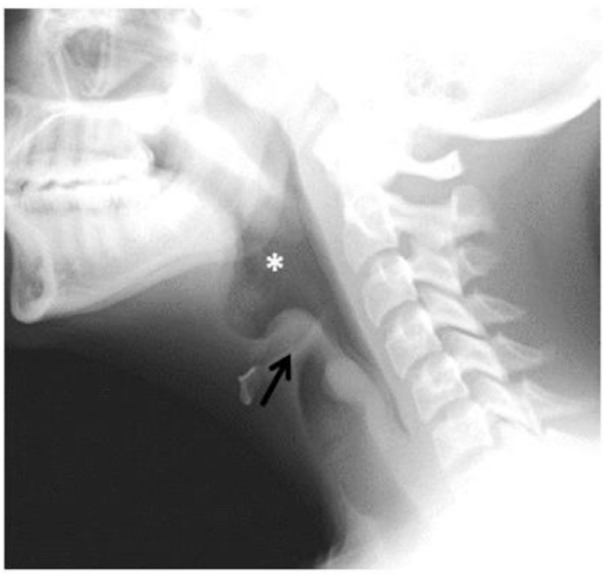

Figure 7 Lateral neck radiograph demonstrating thickening of the epiglottis and aryepiglottic folds with a "thumb print" sign (arrow) and distension of the hypopharynx (*).

Foreign Bodies

In younger children presenting with recurrent unilateral epistaxis, one must also keep in mind the possibility of a foreign body. In the nose, the most frequently encountered entities are beads, buttons, food, and batteries (Fig. 9).[23] These may be able to be successfully removed if identified without the need for imaging, however, imaging can play a role in children where a foreign body is suspected but cannot be directly visualized or when a longstanding foreign body has resulted in edema, bony destruction or scar tissue formation necessitating preoperative planning.[24] On CT and radiography, the metallic foreign bodies are easily identified secondary to their hyperdensity, whereas food matter and cloth will be much less opaque and can appear as either air or intermediate soft tissue density. Foreign bodies may also be inhaled or ingested presenting with respiratory distress or dysphagia so it is important to keep this possibility in mind when imaging children for these indications.

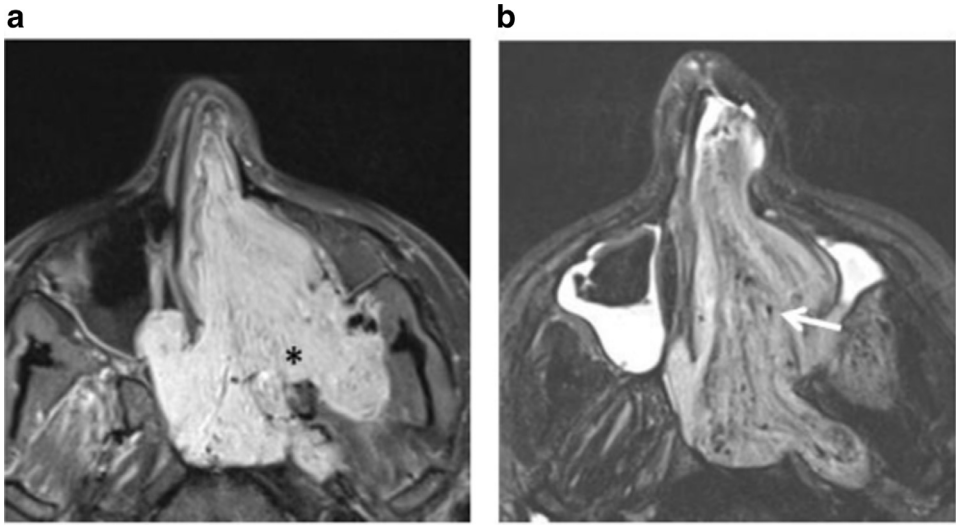

Figure 8 (a) Axial fat saturated post contrast T1 weighted & (b) Axial fast spin-echo inversion recovery magnetic resonance imaging (FSEIR MRI) images of the face demonstrating an avidly enhancing mass (*) with prominent flow voids (arrow) centered within the sphenopalatine foramen (*) extending into the nasal cavity, paranasal sinuses, infratemporal fossa, masticator space, and skull base determined to be a juvenile nasopharyngeal angiofibroma (JNA) at pathology.

Neonate with Respiratory Distress

Respiratory distress is common occurring in up to 7% of newborns[25] and has a variety of medical and surgical causes including obstructive lesions of the airway, the focus of this review. Craniofacial anomalies, tracheal and laryngeal diseases, bilateral choanal atresia, neck masses, and vascular malformations all may present in the neonatal or early infancy period with respiratory distress. Early recognition and management is crucial to ensure good outcomes and imaging plays an important role in this regard.

Choanal Atresia

Congenital choanal atresia is an uncommon anomaly occurring in approximately 1 in 5000-7000 births.[26] It is more commonly unilateral and can be an emergency when bilateral since infants are obligate nose breathers. Management may require temporizing measures such as intubation or placement of an oral airway prior to definitive surgical correction. Additionally, bilateral choanal atresia is often associated with multiple other congenital anomalies including those affecting the airway such as tracheomalacia as well as those affecting the craniofacial structures such as CHARGE syndrome, making this subgroup of patients even more challenging.[27] While clinical evaluation and nasal endoscopy play a role in the workup of these infants, CT scan without contrast is often also performed for definitive assessment and preoperative planning. On CT, one may see thickening of the vomer, thickening of the anterior pterygoid plates, medial bowing of the lateral walls of the nasal cavity and either a bony, soft tissue or mixed atretic plate in the posterior nasal cavity.[28] Nasal secretions may layer within the nasal cavity. (Fig. 10). CT allows differentiation from other causes of nasal obstruction including pyriform aperture stenosis, masses and cysts which may present similarly.

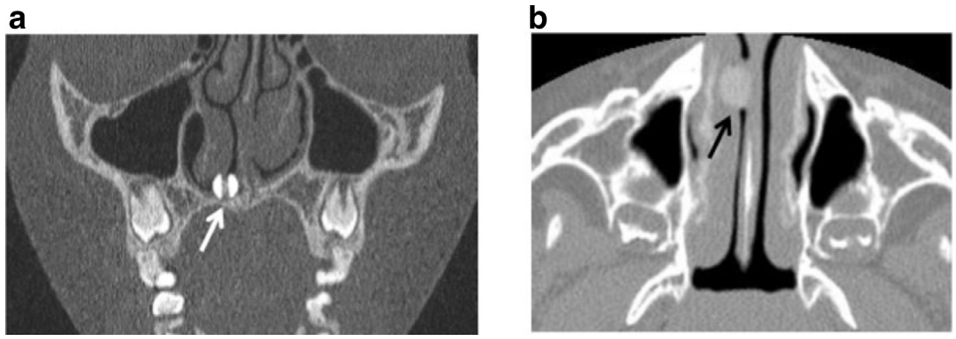

Figure 9 Coronal and axial noncontrast CTs in two different patients. (a) Round hyperdensity along the floor of the right nasal cavity was found to be a bead (white arrow). (b) Intermediate density round focus in the anterior right nasal cavity was found to be a kernel of corn (black arrow).

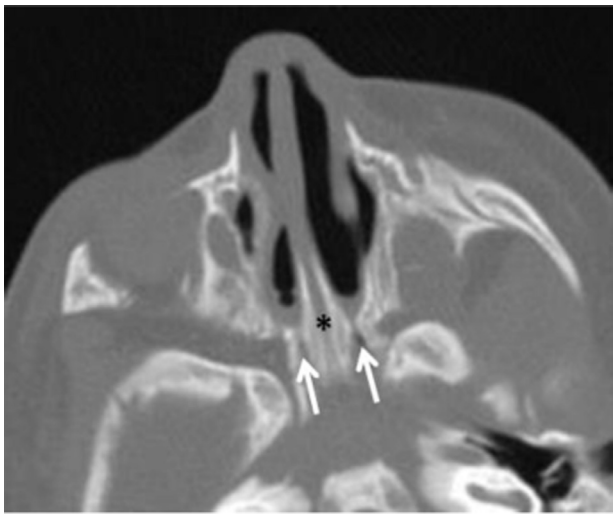

Figure 10 Axial noncontrast CT of the face demonstrating thickening of the vomer (*) and pterygoid plates, medialized walls of the nasal cavity and mixed bony and soft tissue plates in the posterior choana bilaterally (arrows) with layering fluid in the nasal cavities consistent with bilateral choanal atresia.

Neonatal Neck Masses

Neonatal neck masses are an uncommon cause of respiratory distress, but require a coordinated effort on the part of many clinicians and thus, a familiarity with their imaging appearance is needed to guide management. Neck masses may be inconspicuous or incompletely evaluated on routine second trimester obstetric US and MRI is now being performed prenatally in fetuses suspected of having a neck mass to attempt to distinguish among the various pathologies.[29] MRI can delineate the extent of fetal neck masses in terms of the anatomic spaces involved, the relationship to the airway, the presence of intracranial or mediastinal involvement, and detect potential additional fetal anomalies which will in turn affect parental counseling, antenatal and postnatal management.[30] MRI can more readily demonstrate the components of the mass including fat, hemorrhage, and the cystic or solid nature to predict the histology. Imaging may be repeated at several time points prior to delivery for airway management planning and to decide upon the mode of delivery including whether an ex utero intrapartum treatment (EXIT) procedure is needed.[31]

Among the fetal neck masses, lymphatic malformations (LM) are the most common and an attempt should be made to differentiate these from teratomas, which are the most common fetal neck neoplasm, and can appear similarly.[31] When large, both masses can have significant antenatal, perinatal, and postnatal effects due to compression of adjacent critical structures and involvement of the airway and oral cavity. Airway patency should be evaluated on the T2-weighted fetal MRI imaging obtained in multiple planes. An attempt should be made to identify any involvement of the oral cavity including the tongue and there may be polyhydramnios secondary to impaired fetal swallowing. A LM is more frequently trans-spatial and infiltrative and should not have fat or calcific components; however, fat is not reliably a component of the fetal teratomas.[32] The relationship to the thyroid gland can be helpful with teratomas often replacing and involving the thyroid, which will be seen as a claw of tissue around the borders of the mass, whereas an LM displaces or surrounds the thyroid without replacing it (Fig. 11).[33,34] On MRI, LMs may demonstrate fluid-fluid levels within the cystic components, a feature less frequently encountered within the cystic components of teratomas. MRI with contrast is helpful postnatally in differentiating among the neck masses and can be used for preoperative or pretreatment planning.

The Child with Periauricular Pain and Swelling

Coalescent Otomastoiditis

Up to 45% of children will have at least 2 occurrences of acute otitis media by the age of 3 however only a small percentage of these will develop coalescent mastoiditis, characterized by progressive osseous erosion of the mastoid bone secondary to infection.[35,36] Acute coalescent otomastoiditis is associated with a number of complications which can result in significant morbidity and therefore requires prompt recognition and treatment. These children should initially be imaged with contrast-enhanced temporal bone CT with consideration to contrast-enhanced temporal bone MRI if there is concern for intracranial complications such as empyema, labyrinthitis, parenchymal abscess or dural sinus thrombosis.[37] On imaging, the middle ear and mastoid are frequently opacified with erosion of the trabecula of the mastoid and variable erosion of the mastoid cortex with adjacent abscesses. Abscess can be seen around the mastoid tip, known as Bezold's abscess; around the tegmen,

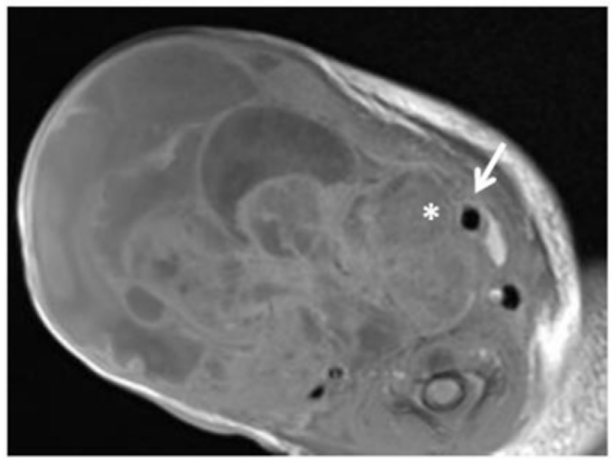

Figure 11 Axial precontrast T1-weighted magnetic resonance imaging (MRI) image demonstrating a large cystic and solid anterior neck mass replacing the right thyroid lobe (*) and deviating the trachea ventrally and to the left (arrow) in a newborn. Pathology confirmed a teratoma.

forming an epidural or temporal lobe abscess; or deep to the medial mastoid forming an epidural or cerebellar abscess. The dural sinuses adjacent to the mastoid may also become thrombosed so a search for filling defects in the sigmoid sinus and jugular vein should be undertaken (Fig. 12).[37] MRI with contrast can also demonstrate abnormal enhancement with the adjacent meninges or along the cranial nerves in the setting of complicating meningitis as well as abnormal enhancement within the inner ear structures in the setting of labyrinthitis, which is facilitated by including postcontrast T1 fat saturated imaging of the temporal bone in the protocol.[37]

Imaging is also useful to diagnose less commonly encountered entities in children presenting with ear pain and swelling including masses such as Langerhan's cell histiocytosis, metastatic neuroblastoma, and other very rare entities including melanocytic neuroectodermal tumors of infancy (Fig. 13). These children will often have more well defined lytic or destructive lesions associated with enhancing soft tissue masses on cross sectional imaging. Both Langerhan's cell histiocytosis and neuroblastoma may also have other sites of involvement in the calvarium with optimal imaging evaluation of these masses including both contrast-enhanced CT and MRI.

Infection of a Congenital Cyst

In children presenting with recurrent periauricular swelling or otorhea one should keep in mind the possibility of a branchial apparatus anomaly, specifically, a first branchial cleft cyst with or without a sinus tract. While these children will more frequently present nonemergently with painless recurrent swelling, these anomalies may become secondarily infected leading to fever, pain, and rarely purulent ear drainage prompting a more urgent visit. The branchial apparatus anomalies are benign congenital lesions derived from remnants of the embryologic anatomy. The most common is the second branchial cleft cyst with the first branchial cleft anomalies accounting for up to 7%.[38] Most frequently, the first branchial cleft anomalies will present as cysts around either the ear pinna or in the parotid.[39] On imaging, one will see a thin walled cyst however if infected, they may demonstrate centrally reduced diffusivity, a thickened enhancing wall and surrounding inflammatory stranding. There can be associated sinus tracts to the external auditory canal, parotid or parapharyngeal space which are important to define on either contrast enhanced CT or MRI, as complete resection is crucial to prevent recurrence (Fig. 14). This congenital anomaly should be differentiated from entities which may also present in children with periauricular swelling including

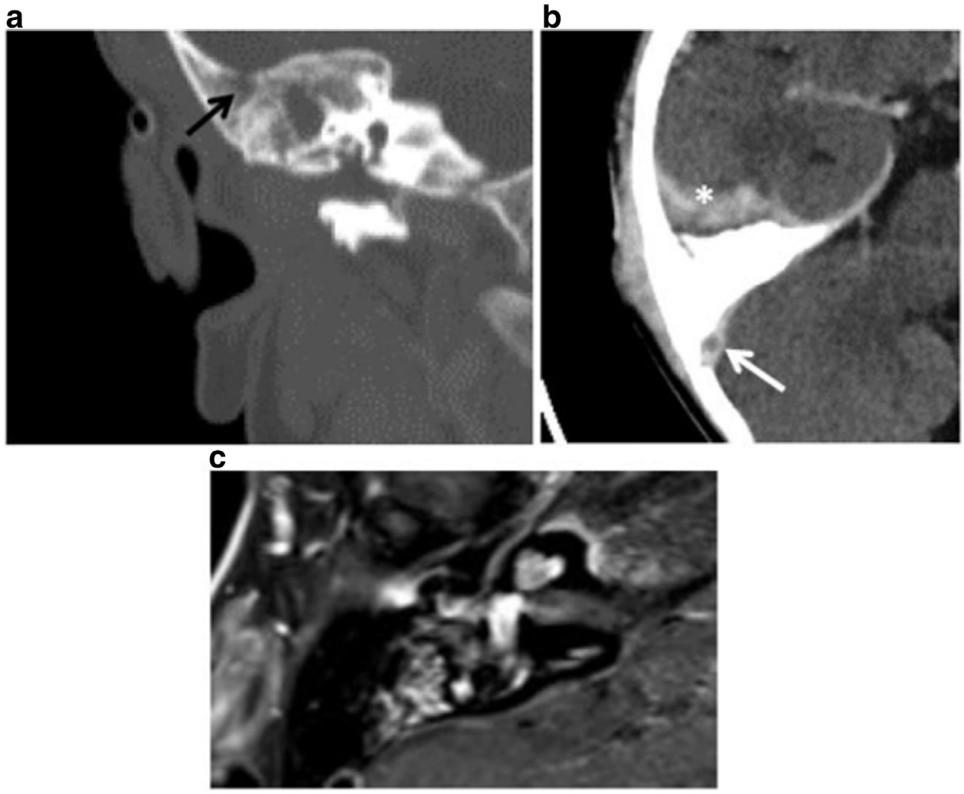

Figure 12 (a) Coronal and (b) axial contrast-enhanced CT images of the temporal bone and (c) axial fat saturated postcontrast T1-weighted magnetic resonance imaging (MRI) image of the temporal bone in a child with coalescent otomastoiditis. (a) There is focal erosion of the tegmen (black arrow). (b) There is a rim enhancing fluid collection in the right middle cranial fossa consistent with an epidural abscess. There is a filing defect within the right sigmoid sinus consistent with dural venous sinus thrombosis (white arrow). (c) There is abnormal enhancement of the cochlea and vestibule consistent with labyrinthitis.

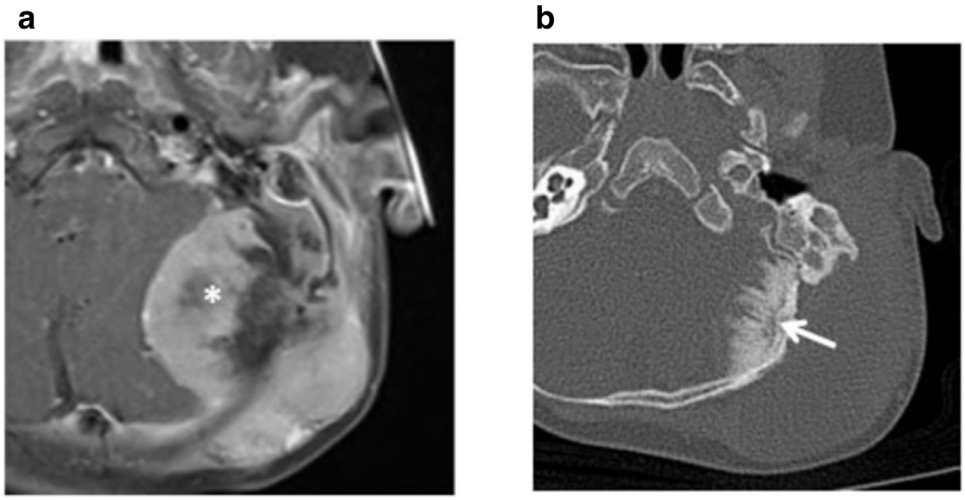

Figure 13 (a) Axial fat saturated postcontrast T1-weighted magnetic resonance imaging (MRI) image of the brain and (b) axial contrast-enhanced CT of the head in bone window. (a) Infant with a large heterogeneously enhancing mass centered in the left mastoid and occipital bone extending intracranially. (*) (b) The mass has a spiculated sunburst appearance of the involved bone (arrow). Pathology determined the mass to be a melanotic neuroectodermal tumor of infancy.

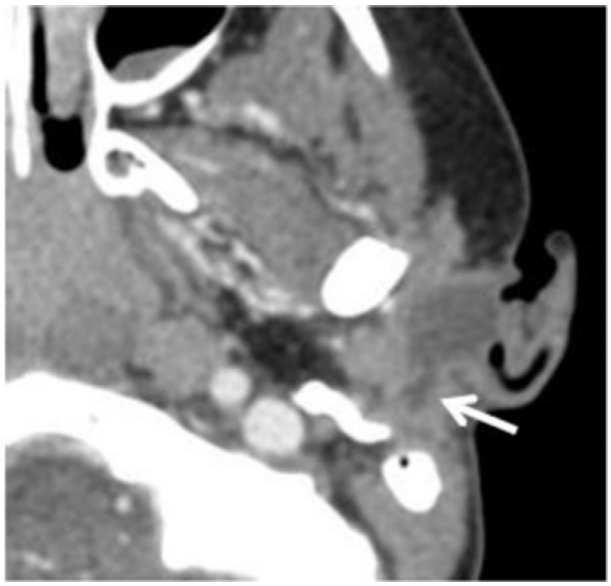

Figure 14 Axial contrast enhanced CT in a patient with recurrent parotid swelling and otorrhea demonstrates a cystic lesion within the left parotid and a tract coursing towards the external auditory canal (arrow) found to be a first branchial apparatus anomaly at surgery.

nontuberculous mycobacterial infection, acute parotitis, and vascular malformations.[40]

Conclusions

Diagnosing children presenting with a variety of nontraumatic head and neck emergencies is challenging as the clinical presentations may overlap and management must be expedient. The radiologist plays an important role in guiding the clinician in choosing the appropriate imaging modality, distinguishing among the most commonly encountered illnesses, defining the extent of pathology, and recommending specific further testing when necessary. Familiarity with the imaging appearance of the disease entities frequently seen in the head and neck of children on US, radiography, CT, and MRI can facilitates optimal management for these patients.

References

1. [No authors listed]. The ALARA (as low as reasonably achievable) concept in pediatric CT: Intelligent dose reduction. Multidisciplinary conference organized by the Society for Pediatric Radiology August 18–19, 2001 Pediatr Radiol 32:217-313, 2002
2. American College of Radiology (ACR) Website. Appropriateness Criteria. http://www.acr.org/Quality-Safety/Appropriateness-Criteria. Accessed August 1, 2018
3. Smith TF, O'Day D, Wright PF: Clinical implications of preseptal (periorbital) cellulitis in childhood. Pediatrics 62:1006, 1978
4. Okonkwo ACO, Powell S, Carrie S, et al: A review of periorbital cellulitis guidelines in Fifty-One Acute Admitting Units in the United Kingdom. Clin Otolaryngol 43:718-721, 2018. Apr
5. Sciarretta V, Demattè M, Farneti P, et al: Management of orbital cellulitis and subperiosteal orbital abscess in pediatric patients: A ten-year review. Int J Pediatr Otorhinolaryngol 96:72-76, 2017. May
6. Ali MJ: Pediatric acute dacryocystitis. Ophthalm Plast Reconstr Surg 31:341-347, 2015
7. Saito N, Nadgir RN, Flower EN, et al: Clinical and radiologic manifestations of sickle cell disease in the head and neck. Radiographics 30:1021-1034, 2010. Jul-Aug
8. McBride CL, Mai TK-B, Kumar KS: Orbital infarction due to sickle cell disease without orbital pain. Case Rep Ophthalmol Med 2016:4, Article ID :5867850, 2016. https://doi.org/10.1155/2016/5867850.
9. Hing E, Hall MJ, Xu J: National Hospital Ambulatory Medical Care Survey: 2006 Outpatient Department Summary. Hyattsville, MD: National Health Statistics Reports, 2008
10. Wessels MR: Clinical practice. Streptococcal pharyngitis. N Engl J Med 364:648-655, 2011. Feb 17

11. Secko M, Sivitz A: Think ultrasound first for peritonsillar swelling. Am J Emerg Med 33:569-572, 2015. Apr
12. Schraff S, McGinn JD, Derkay CS: Peritonsillar abscess in children: A 10-year review of diagnosis and management. Int J Pediatr Otorhinolaryngol 57:213-2188, 2001
13. Windfuhr J: Malignant neoplasia at different ages presenting as peritonsillar abscess. Otolaryngol Head Neck Surg 126:197-198, 2002
14. Derinkuyu BE, Boyunağa Ö, Öztunalı Ç, et al: Imaging features of Burkitt lymphoma in pediatric patients. Diagn Interv Radiol 22:95-100, 2016. Jan
15. Wilson CD, et al: Retrospective review of management and outcomes of pediatric descending mediastinitis. Otolaryngol Head Neck Surg 155:155-159, 2016
16. Maroldi R, et al: Emergency imaging assessment of deep neck space infections. Semin Ultrasound CT MR 33:432-442, 2012
17. Shefelbine SE, et al: Pediatric retropharyngeal lymphadenitis: differentiation from retropharyngeal abscess and treatment implications. Otolaryngol Head Neck Surg 136:182-188, 2007
18. Guldfred LA 1, Lyhne D, Becker BC: Acute epiglottitis: Epidemiology, clinical presentation, management and outcome. J Laryngol Otol 122:818-823, 2008. Aug
19. Guardiani E, et al: Supraglottitis in the era following widespread immunization against Haemophilus influenzae type B: Evolving principles in diagnosis and management. Laryngoscope 120:2183-2188, 2010
20. Tresley J, Saraf-Lavi E, Kryvenko O, et al: Epiglottic masses identified on CT imaging: A case report and review of the broad differential diagnosis. Neuroradiol J 28:347-353, 2015
21. Kania RE, et al: Early postoperative CT scanning for juvenile nasopharyngeal angiofibroma: Detection of residual disease. AJNR Am J Neuroradiol 26:82-88, 2005
22. Martins MBB, de Lima FVF, Mendonça CA, et al: Nasopharyngeal angiofibroma: Our experience and literature review. Int Arch Otorhinolaryngol 17:14-19, 2013
23. Heim SW, Maughan KL: Foreign bodies in the ear, nose, and throat. Am Fam Physician 76:1185-1189, 2007. Oct 15
24. Chan TC, Ufberg J, Harrigan RA, et al: Nasal foreign body removal. J Emerg Med 26:441-445, 2004
25. Edwards MO, et al: Respiratory distress of the term newborn infant. Paediatr Respir Rev 14:29-36, 2013. Mar
26. Ramsden JD, Campisi P, Forte V: Choanal atresia and choanal stenosis. Otolaryngol Clin North Am 42:339-352, 2009
27. Gujrathi, et al: Management of bilateral choanal atresia in the neonate: An institutional review. Int J Pediatr Otorhinolaryngol 68:399-407, 2004
28. Aslan S, et al: Comparison of nasal region dimensions in bilateral choanal atresia patients and normal controls: A computed tomographic analysis with clinical implications. Int J Pediatr Otorhinolaryngol 73:329-335, 2009
29. Bulas D, Egloff A: Benefits and risks of MRI in pregnancy. Semin Perinatol 37:301-304, 2013
30. Cass DL: Impact of prenatal diagnosis and therapy on neonatal surgery. Semin Fetal Neonatal Med. 16:130-138, 2011
31. Tonni G, De Felice C, Centini G, et al: Cervical and oral teratoma in the fetus: A systematic review of etiology, pathology, diagnosis, treatment and prognosis. Arch Gynecol Obstet 282:355-361, 2010
32. Woodward PJ, Sohaey R, Kennedy A, et al: A comprehensive review of fetal tumors with pathologic correlation. Radiographics 25:215-242, 2005
33. Martino F, Avila LF, Encinas JL, et al: Teratomas of the neck and mediastinum in children. Pediatr Surg Int 22:627-634, 2006
34. Cho JY, Lee YH: Fetal tumors: prenatal ultrasonographic findings and clinical characteristics. Ultrasonography 33:240-251, 2014. Oct
35. Psarommatis IM, et al: Algorithmic management of pediatric acute mastoiditis. Int J Pediatr Otorhinolaryngol 76:791-796, 2012
36. Teele DW, Klein JO, Rosner BA: Epidemiology of otitis media in children. Ann Otol Rhinol Laryngol Suppl 89:5-6, 1980. May-Jun
37. Vazquez E, et al: Imaging of complications of acute mastoiditis in children. Radiographics 23:359-372, 2003
38. Schroeder JW Jr, et al: Branchial anomalies in the pediatric population. Otolaryngol Head Neck Surg 137:289-295, 2007
39. Martinez Del Pero M, et al: Presentation of first branchial cleft anomalies: the Sheffield experience. J Laryngol Otol 121:455-459, 2007
40. Koch BL: Cystic malformations of the neck in children. Pediatr Radiol 35(5):463-477, 2005