Laryngeal injuries are serious but rare injuries that may be missed on imaging performed in patients sustaining blunt laryngeal trauma. In this paper from the Brigham and Women’s Hospital in Boston, Mass, the authors begin with a description of the evolution of imaging of blunt laryngeal injuries to the current use of multi-detector CT, and offer their protocol for neck CT with or without angiography. A detailed, annotated review of normal laryngeal anatomy as depicted on CT is provided in Figure 2. Table 1 then provides a list of anatomic sites to be evaluated on CT with associated abnormalities and their clinical significance. This begins with evaluation of the soft tissues and both the supraglottic and subglottic airway. Illustrated soft tissue injuries include supraglottic hematoma and avulsion of the epiglottis. Laryngeal soft tissue injuries are often associated with subcutaneous emphysema. The complex anatomy and irregular ossification of the laryngeal skeleton make laryngeal fracture detection challenging. Thyroid cartilage fractures are the most common laryngeal skeletal injury, with vertically-oriented paramedian fractures resulting from anteroposterior compression injuries and bilateral horizontally-oriented fractures seen from manual strangulation. Coronal MIP images are particularly helpful in laryngeal skeletal evaluation. Subglottic injuries include those to the cricoid cartilage and cervical trachea. Cricoid injuries require significant force and are typically multiple owing to the ring structure of the cricoid cartilage. This and other posteriorly-situated injuries involving the aerodigestive soft tissues are particularly important as they are prone to injury due to compression against the cervical spine and associated edema tends to spread anteriorly resulting in airway compromise. Iatrogenic laryngeal injury is not uncommon, said to occur in 10% of patients after short-term intubation for surgery. It is therefore important for the radiologist to evaluate the proper positioning of all support tubes seen on the CT scans, as Figure 10 illustrates a case with extratracheal tube passage in a patient undergoing attempted orotracheal intubation following blunt neck trauma. It is important to highlight a few of our articles that I think are important.

**Primary and Secondary Breast Lymphoma: Clinical, Pathologic, and Multimodality Imaging Review**

RadioGraphics 2019; 39:610–625

Sean D. Raj, MD • Mahmud Shurafa, MD • Zeeshan Shah, MD • Karuna M. Raj, MD • Michael D. C. Fishman, MD • Vandana M. Dialani, MD

Although a rare breast tumor, lymphoma is the most common metastasis to the breast, accounting for 17% of metastatic disease. In this review paper found in the current May 2019 issue of *RadioGraphics*, Dr. Sean Raj and colleagues from Baylor University Medical Center and UT Southwestern in Dallas, Texas and the Beth Israel Deaconess Medical Center in Boston, Massachusetts begin with a review of the clinical features of primary and secondary breast lymphoma, with primary disease defined as the absence of a previous extramammary lymphoma diagnosis and the absence of concurrent widespread disease. The authors remind us that there are no specific clinical features to allow distinction of breast lymphoma from invasive ductal or lobular breast cancer. Affected patients present with an enlarging painless palpable breast mass, although 10% are detected at screening mammography. Nipple retraction or discharge is uncommon in breast lymphoma. Primary breast lymphoma is almost always a non-Hodgkin lymphoma, most commonly diffuse large B-cell lymphoma. Primary disease is felt to arise from intramammary lymph nodes; a right-sided predominance has been reported. At mammography a solitary round or oval mass is typical; calcifications within the lesion are rare. A hypoechoic or mixed echogenic mass with internal vascularity is most common at US, while PET/CT is used for staging and to assess response to treatment. MR has a limited role but may be helpful in detecting multifocal disease. Imaging features that may suggest secondary breast lymphoma include multiple masses or the presence of an inflammatory-like appearance with trabecular and skin thickening in the absence of a mass; on US an oval or round shape and circumscribed margins favor secondary breast lymphoma over primary lymphoma or carcinoma. The rare entity of breast implant-associated anaplastic large-cell lymphoma is a T-cell lymphoma that develops in proximity to breast implants; peri-implant effusions that develop more than a year after textured breast implant placement should raise this diagnostic possibility, with fluid aspirated under US guidance sent for cytologic analysis. The paper reviews the issue of fine-needle aspiration and core biopsy for lymphoma diagnosis, and in Figure 12 offers a radiologic-pathology algorithm for use in cases of suspected breast lymphoma. A brief review of breast lymphoma pathology is provided; important morphologic, immunohistocytochemical and molecular features are reviewed. The paper concludes with a section on treatment and prognosis; surgery, chemotherapy and radiation therapy all contribute to the treatment armamentarium in selected cases.

**Multidetector CT of Laryngeal Injuries: Principles of Injury Recognition**


Junzi Shi, MD • Jennifer W. Uyeda, MD • Alejandra Duran-Mendicuti, MD • Christopher A. Potter, MD • Diego B. Nunez, MD, MPH

Fractures of the laryngeal skeleton are the most common laryngeal skeletal injury, with complex anatomy and irregular ossification of the laryngeal skeleton. Laryngeal trauma is often associated with subcutaneous emphysema. The posterior compression injuries and bilateral horizontally-oriented fractures seen from manual strangulation. Coronal MIP images are particularly helpful in laryngeal skeletal evaluation. Subglottic injuries include those to the cricoid cartilage and cervical trachea. Cricoid injuries require significant force and are typically multiple owing to the ring structure of the cricoid cartilage. This and other posteriorly-situated injuries involving the aerodigestive soft tissues are particularly important as they are prone to injury due to compression against the cervical spine and associated edema tends to spread anteriorly resulting in airway compromise. Iatrogenic laryngeal injury is not uncommon, said to occur in 10% of patients after short-term intubation for surgery. It is therefore important for the radiologist to evaluate the proper positioning of all support tubes seen on the CT scans, as Figure 10 illustrates a case with extratracheal tube passage in a patient undergoing attempted orotracheal intubation following blunt neck trauma. It is important
that airway management is addressed before CT is performed; a laryngotracheal injury classification system, which is Table 2 in the paper, uses laryngoscopic findings to group injuries into 5 categories which helps determine whether the patient should undergo preoperative CT or should be taken directly to surgery for their injuries. Pitfalls in diagnosis primarily center around the variability in laryngeal structure and degree of cartilaginous ossification. While soft tissue emphysema is an important finding in airway injuries, a lack of air on imaging does not confidently exclude the presence of a laryngeal injury.

**Ligaments and Lymphatic Pathways in Gastric Adenocarcinoma**

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Jennifer J. Young, MD • Anokh Pahwa, MD • Maitraya Patel, MD • Cecilia M. Jude, MD • Michael Nguyen, MD • Monica Deshmukh, MD • Lizhou Huang, MD • Shaden F. Mohammad, MD

This article from authors at the UCLA Medical Center detailing the pathways of spread of gastric adenocarcinoma begins with a review of the imaging techniques used for the diagnosis and staging of this disease. Double-contrast upper GI fluoroscopic examination is a low-cost examination that can be used as the initial study to evaluate symptomatic patients prior to endoscopic evaluation. The CT protocol used to optimize gastric evaluation is detailed next. While MRI has little role in gastric cancer evaluation, FDG PET/CT is useful for the evaluation of distant disease. Following an illustrated review of the normal gastric anatomy and vascularity, the paper focuses on the normal gastric mucosa and rugal folds as depicted fluoroscopically and endoscopically. After a review of the normal gastric wall as seen on CT, there is an extensive review of the 5 perigastric ligaments, highlighted by anatomic drawings and correlative CT images. Table 1 provides a list of these ligaments with their typical course, associated vascularity, source of tumor spread, and potential resultant end organ involvement. The abundant perigastric lymphatics drain the stomach into the Japanese Gastric Cancer Association-designated gastric nodal stations numbered 1-20 and lower thoracic stations 110-112 and are listed in Table 2. The paper then proceeds to review the imaging findings of gastric adenocarcinoma, beginning with upper GI series findings including polypoid lesions, ulceration, indistensibility, and gastric outlet obstruction. CT findings of gastric cancer include gastric wall thickening, abnormal gastric wall enhancement, obliteration of the normal gastric wall layers, perigastric fat stranding, and perigastric lymphadenopathy. The CT criteria used to determine the various T categories, along with the nodal and metastatic disease characterization, are reviewed in Table 3 and illustrated with multiple cases. The multiple pathways of spread include lymphatic dissemination; subperitoneal dissemination along the perigastric ligaments, mesentery, or omentum; direct invasion of adjacent organs; transperitoneal seeding; and/or hematogenous dissemination. The most frequent nodal groups involved are based upon the portion of stomach involved and are listed in Table 4; regional and nonregional or distant nodal groups that determine the nodal and metastatic status of disease are detailed. Subperitoneal dissemination, direct invasion of adjacent organs, transperitoneal spread of disease and hematogenous dissemination are then reviewed as depicted primarily on CT. The paper concludes with a list of the essential radiologic findings that affect clinical stage, treatment, and prognosis which are perigastric fat stranding, lymph node involvement, perigastric ligament involvement, direct invasion into adjacent organs, and metastases. These findings affect treatment options and can be used to predict outcomes in patients with gastric adenocarcinoma.

**Imaging Spectrum of Cavernous Sinus Lesions with Histopathologic Correlation**


Harsha Vardhan Mahalingam, MD • Sunithi E. Mani, MD • Bimal Patel, MD • Krishna Prabhu, MCh • Mathew Alexander, DM • Girish M. Fatterpekar, MD • Geeta Chacko, MD

In this radiologic pathology correlation review article from authors at the Christian Medical College in Vellore, India and the NYU Langone Medical Center in New York, NY, the authors begin with an illustrated review of the anatomy of the cavernous sinus and sella turcica, the segments and major branches of the cavernous segments of the internal carotid artery, and the venous connections of the cavernous sinus. As the authors point out, the veins and nerves passing through the cavernous sinus and the fissures and foramina surrounding the cavernous sinus act as pathways for the spread of disease to and from the cavernous sinus; these pathways are illustrated in Figure 4. After reviewing the neoplastic, vascular, inflammatory, and miscellaneous etiologies of cavernous sinus pathology presented diagrammatically in Figure 5, the authors detail their MR imaging protocol for suspected cavernous sinus lesions in Table 3; the coronal thin-section high-spatial resolution T2-weighted and axial and coronal pre- and post-contrast thin-section fat-suppressed T1-weighted sequences are the mainstays for interpretation. Beginning with neoplasia, the paper reviews the imaging and pathology of meningioma, which is the most common cavernous sinus tumor, schwannoma/neurofibroma, and additional cases of solitary fibrous tumor/hemangiopericytoma complex, cavernous hemangioma, and melanocytic tumor. Tumors that arise from adjacent structures and secondarily invade the cavernous sinus include pituitary adenomas, juvenile nasopharyngeal angiofibroma, chondrosarcoma, and other tumors including suprasellar neoplasms and systemic neoplasms such as lymphoma and myeloma. The spectrum of vascular conditions that include cavernous sinus thrombosis, carotid-cavernous fistula, and internal carotid artery aneurysm are illustrated with correlative angiographic findings provided. Invasive fungal disease that has spread to the cavernous sinus from the paranasal sinuses is most...
commonly encountered in immunocompromised patients and can be difficult to distinguish from inflammatory conditions and neoplasms such as lymphoma; clues include a sheet-like configuration of the abnormal tissue and T2 hypointensity. Other non-infectious inflammatory conditions reviewed include sarcoidosis, IgG4-related disease, and Tolosa-Hunt syndrome. Cystic lesions include epidermoid and dermoid cysts, arachnoid cysts, and CSF pseudocysts. The concluding section reviews pitfalls in interpretation and also provides a table and diagnostic algorithm with imaging clues to the proper diagnosis of the various cavernous sinus lesions detailed in this paper, based primarily on their MR features.

**Advanced CT Techniques for Decreasing Radiation Dose, Reducing Sedation Requirements, and Optimizing Image Quality in Children**

Ravi V. Gottumukkala, MD • Mannudeep K. Kalra, MD • Azadeh Tabari, MD • Alexi Otrakji, MD • Michael S. Gee, MD, PhD

From the Department of Radiology at the Massachusetts General Hospital, Dr. Ravi Gottumukkala and colleagues discuss three strategies that can be used as part of a comprehensive approach to reducing radiation dose and sedation requirements and optimizing the image quality of CT in children. Following an introduction, the first strategy is dual-energy CT techniques, with Table 1 listing the various hardware options with their associated benefits and limitations. Applications include the ability to obtain virtual nonenhanced images that allows single phase scanning with considerable reduction in radiation dose. Virtual monoenergetic imaging provides for reduction of streak artifacts due to hardware with two examples in the spine and chest shown for illustration. Low monoenergetic virtual images can help increase the conspicuity of iodinated contrast, thereby enabling use of lower contrast volumes and/or injection rates. The second technique explored is low-kilovoltage imaging. Given that dose decreases as a product of the square of tube voltage, one can achieve greater reduction in dose by lowering tube voltage particularly because the marginal compensatory increase in tube current that is needed to maintain image quality is lower in children than in adults. Additionally, the lower tube potential increases iodine attenuation, thereby increasing the enhancement characteristics of diagnostic findings. As a result, high-contrast examination studies such as CT angiography and CT urography achieve the greatest reduction in radiation dose by reducing tube voltage. The final technique employed is rapid acquisition using ultrahigh-pitch scanning which can reduce motion degradation and potentially obviate the need for sedation in infants and young children. The authors review the concepts behind dual source CT scanners that allow for a pitch of 3.2–3.4 as compared to single-source units that are usually limited to a maximum pitch of 1.5. Multiple examples of diagnostic quality CT examinations in awake, non-sedated and free-breathing children scanned with ultrahigh-pitch acquisitions are provided. The final section of the paper reviews the use of wide-area detector CT that allows for axial scanning of an entire anatomic region in a single gantry rotation without table motion, thereby reducing dose as compared to helical acquisition. Optimal applications include scans that image less than or equal to the 16 cm detector width as can be performed in infants, young children, or the scanning of shorter regions of interest including the head, neck, heart, or single extremity joint. Table 6 at the end of the paper provides estimated scan times for the various hardware options and scan modes that are discussed.

**Multimodality Imaging of Focal and Diffuse Fibrosing Mediastinitis**

Sherief H. Garrana, MD • Jennifer R. Buckley, MD • Melissa L. Rosado-de-Christenson, MD • Santiago Martínez-Jiménez, MD • Phillip Muñoz, MD • John J. Borsa, MD

Fibrosing mediastinitis, also known as sclerosing mediastinitis or mediastinal fibrosis, is an uncommon inflammatory condition divided by etiology and extent into granulomatous or focal subtype and non-granulomatous or diffuse subtype. The major features of each of these two subtypes are summarized in a table at the beginning of the article. Following a review of the demographics, clinical features and microscopic features of this entity, the article begins its review of the imaging of fibrosing mediastinitis including a brief discussion of chest radiography, which is limited in diagnostic utility. Contrast-enhanced CT is the modality of choice for evaluating patients with suspected fibrosing mediastinitis, as it readily depicts the presence of a localized or infiltrative soft tissue mass with calcifications that most commonly affects the right paratracheal or subcarinal region or the hila. While MRI is not typically utilized for diagnosis, FDG-PET is sometimes obtained in patients suspected of having malignancy, and FDG avidity in fibrosing mediastinitis may make differentiation from malignancy difficult. The paper then provides a review of the spectrum of imaging findings and complications associated with fibrosing mediastinitis. Airway involvement typically involves the central tracheobronchial tree with bronchial stenosis or complete obstruction resulting in post-obstructive pneumonitis, distal atelectasis or distal bronchiectasis. Pulmonary arterial involvement may produce arterial narrowing or occlusion with hypoperfusion, while venous involvement can produce congestion with findings of localized or unilateral edema seen on CT as septal lines, ground glass opacity, bronchial wall thickening, and pleural effusion. Systemic vein involvement most often affects the superior vena cava with potential SVC occlusion that may present clinically as the SVC syndrome; SVC syndrome is considered the most frequent serious complication of fibrosing mediastinitis. While the diagnosis of granulomatous fibrosing mediastinitis is usually made by the recognition of characteristic imaging findings in a young patient living in an area endemic for histoplasmosis, which is the most common cause of granulomatous fibrosing
mediastinitis, other findings of prior histoplasmosis including calcified nodules in the lungs, liver and spleen can help confirm a presumptive diagnosis. In cases where the diagnosis is not clear and distinction from malignancy is not possible, tissue biopsy may be necessary. Prognosis is generally good; treatment is usually targeted to those mediastinal structures compromised and can include angioplasty and balloon dilation of airways with vascular or bronchial stenting when necessary.

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