

Cranial Nerves, Sinuses, and Neck Masses

Donald L. Renfrew, MD

This chapter reviews imaging of symptoms related to the cranial nerves (or the central nervous system structures associated with the cranial nerves) and paranasal sinuses. It also reviews imaging of neck masses. The three main points of this chapter are:

1. Symptoms of cranial nerve abnormality may require MRI of the brain.
2. Patients with symptoms of sinusitis (purulent nasal discharge and/or facial pain/pressure) usually do not require imaging. CT is the study of choice when imaging is necessary.
3. Palpable thyroid lesions can undergo FNAB without imaging, whereas nonthyroid neck masses typically require CT scanning prior to biopsy.

SYMPTOMS OF CRANIAL NERVE ABNORMALITY MAY REQUIRE MRI OF THE BRAIN

Evaluation of patients with symptoms which may be related to the cranial nerves starts with a history and physical examination directed toward deciphering whether the symptoms are actually arising from the cranial nerve itself or because of an abnormality of the brainstem (or elsewhere in the

brain). As a generalization, isolated involvement of a single cranial nerve is likely to be caused by either intrinsic dysfunction of the nerve (typically demonstrating either no imaging findings or manifesting as contrast enhancement along the nerve on an MRI study) or occasionally by a mass compressing the nerve. Symptoms from multiple cranial nerves or other additional symptoms (headache, pain, non-cranial nerve neurologic abnormalities) that suggest a brain abnormality require a brain MRI done without and with contrast. The routine brain sequences may be supplemented with thin cuts through the pituitary gland (for cranial nerves II - VI) or posterior fossa (for cranial nerves VII - XII) after intravenous contrast. The following paragraphs further discuss symptoms arising from each of the cranial nerves.

Cranial Nerve I symptom: Anosmia

Gradual onset of loss of smell may accompany sinus disease, allergic rhinitis, or dementia, while sudden onset of loss of smell may be secondary to head injury or viral infection¹. Patients with acute onset of anosmia should probably be referred to an otolaryngologist for examination of the nasal cavity and paranasal sinuses. Imaging studies may include CT of the paranasal sinuses if there are symptoms of sinusitis (see below) and/or brain MR if there are symptoms of central nervous system disease.

Cranial Nerve	Major Function(s)	Associated Symptoms
I – olfactory	Smell	Anosmia
II – optic	Vision	Decreased or absent vision
III – oculomotor	Extraocular muscles; levator palpebrae; pupillary muscles	Double vision and abnormal eye motion; ptosis; abnormal pupil size
IV – trochlear	Superior oblique muscle	Double vision and abnormal eye motion
V – trigeminal	Facial sensation; muscles of mastication	Facial pain
VI – abducens	Lateral rectus muscle	Double vision and abnormal eye motion
VII – facial	Facial muscles	Bell’s palsy
VIII – vestibulocochlear	Equilibrium	Dizziness, vertigo
	Hearing	Tinnitus, hearing loss
IX – glossopharyngeal	Taste, pharynx sensation	Loss of gag reflex and taste (bitter, sweet, sour, salty)
X – vagus	Muscles of larynx and pharynx, taste, heart rate, digestion	Impaired swallowing
XI – spinal accessory	Pharynx, trapezius and sternocleidomastoid muscles	Impaired swallowing
XII – hypoglossal	Tongue movements	Impaired swallowing

Table. Cranial nerves, function, and symptoms when functioning incorrectly.

Cranial Nerve II symptom: decreased vision and loss of vision

Chronic vision loss is typically the concern of the optometrist or ophthalmologist rather than the primary care provider. However, the primary care provider may see patients with acute vision loss. Acute transient monocular vision loss (amaurosis fugax) may be caused by embolic or hemodynamic vascular abnormalities². This symptom represents a TIA/stroke equivalent, and should be managed as such, with aggressive timely work-up either on an inpatient or closely monitored outpatient basis. Imaging should include MRI of the brain and either

magnetic resonance angiography (MRA) or computed tomographic angiography (CTA) of the arch and carotid arteries, or at least ultrasound of the neck vessels, to evaluate for vascular occlusion, stenosis, dissection, or other causative vascular abnormality (see pages 47-49).

When acute monocular vision loss occurs in a younger patient, particularly if there is associated movement disorder or an afferent papillary defect, MRI of the brain without and with contrast should be obtained to exclude multiple sclerosis³ (Figure 1) (see pages 51-53).

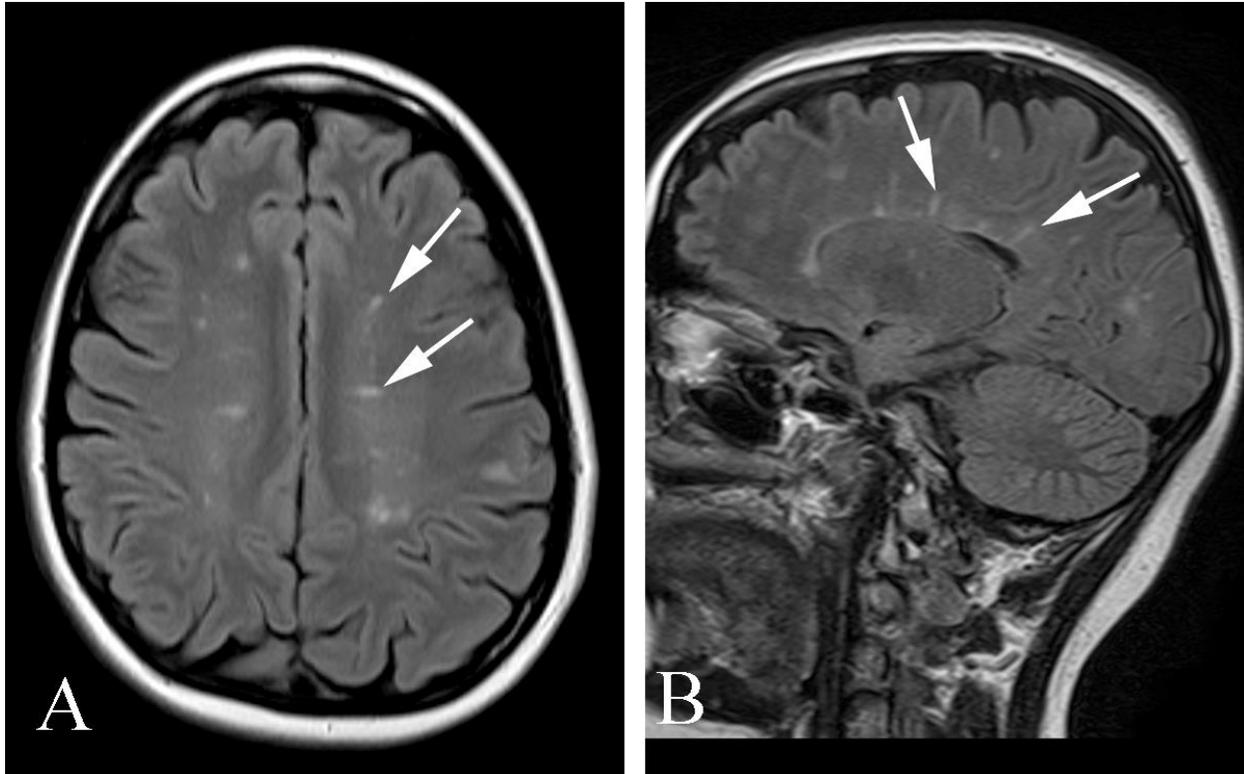


Figure 1. Multiple sclerosis in a 35 year old woman with blurred vision in one eye along with numbness in both hands. A. Axial FLAIR MR shows multiple foci of increased signal intensity (arrows). B. Sagittal FLAIR MR also shows multiple foci of increased signal intensity, including several lesions of the corpus callosum (arrows), typical for multiple sclerosis.

For patients with diminished temporal visual fields (bitemporal hemianopsia), routine brain MR sequences should be supplemented with examination of the pituitary fossa for adenoma; typically, contrast-enhanced thin cuts through the pituitary are obtained following IV contrast enhancement⁴.

Cranial Nerve III, IV, and VI symptom: diplopia

Proper care of patients with diplopia depends upon differentiating the patients with double vision secondary to isolated cranial nerve abnormality from those with multiple abnormal cranial nerves. Isolated cranial nerve abnormality generally implies a benign cause and likely resolution (or at least improvement) of the process with time, whereas diplopia associated with multiple cranial nerve abnormalities requires an expedited work-up to evaluate for possible intracranial abnormalities⁵. For younger patients (where multiple sclerosis is a concern), MR done without and with contrast should be performed (Figure 2) (see pages 51-53).

For older patients and others where a vascular cause is suspected, MRI without and with contrast and vascular imaging should be performed (Figure 3) (see pages 47-49).

Cranial Nerve V symptoms: trigeminal neuralgia

The fifth cranial nerve (also known as the trigeminal nerve because of its supraorbital, maxillary, and mandibular divisions) is primarily a sensory nerve, and the chief symptom arising from dysfunction is severe, unilateral lancinating facial pain (also known as tic douloureux). This pain is highly characteristic, but because the same pain may be caused by multiple sclerosis (see pages 51-53) or a cerebellopontine angle tumor, MRI of the brain without and with contrast should usually be performed⁶. Note that unilateral facial pain may also be caused by dental disease, temporomandibular joint dysfunction, temporal arteritis, sphenoid sinusitis (see below), and cluster headache (see page 29)⁶.

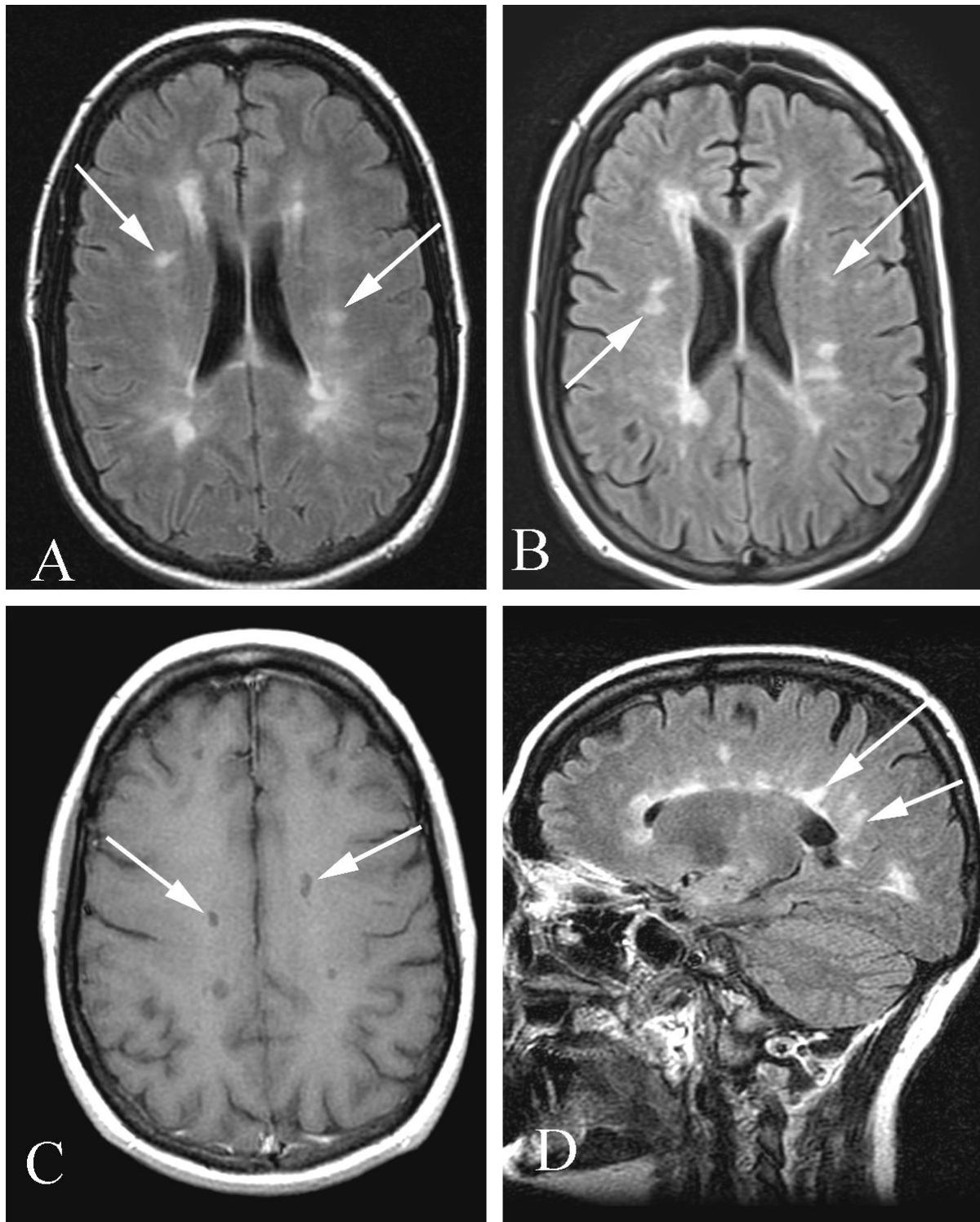


Figure 2. Multiple sclerosis in a 41 year old woman with diplopia. A. Axial FLAIR MR shows multiple foci of increased signal intensity (arrows). B. Axial FLAIR MR at a slightly different level shows multiple additional oblong foci of increased signal intensity (arrows) with the long axis of the abnormalities perpendicular to the lateral ventricles. C. Axial T1 weighted post-contrast examination shows multiple foci of decreased signal intensity (arrows) in the white matter of the cerebral hemispheres. D. Sagittal FLAIR MR shows multiple foci of increased signal intensity, including several lesions of the corpus callosum (arrows), typical for multiple sclerosis.

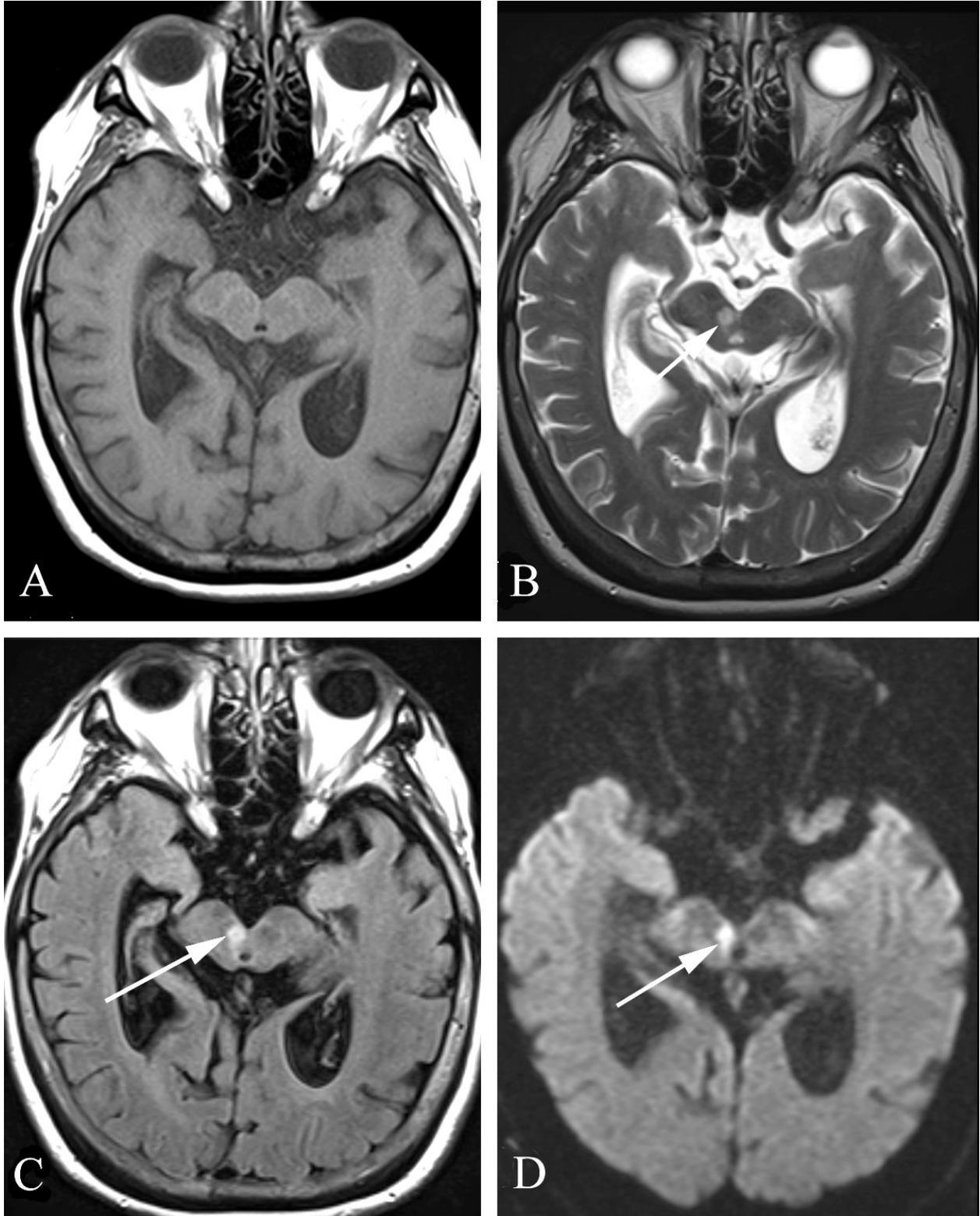


Figure 3. Stroke in a 70 year old woman with diplopia (and dizziness) beginning 4 days prior to the MR study. A. Axial T1 weighted MR is normal. B. Axial FLAIR MR shows a focus of increased signal intensity in the right brainstem (arrow). C. Axial FLAIR image also shows abnormal signal in the right brainstem (arrow). D. Axial diffusion weighted image demonstrates increased signal indicating restricted diffusion, characteristic of a stroke.

Cranial Nerve VII abnormality: Bell's palsy or idiopathic facial neuropathy

Abrupt paralysis of the facial nerve, or Bell's palsy, is typically highly characteristic, self-limited, and should be recognized by the primary care provider. It generally does not require imaging if isolated⁷. As with other cranial nerve symptoms, when multiple cranial nerve symptoms or central nervous system abnormalities are in question, MRI without and with contrast with additional thin cuts through the posterior fossa is in order.

Cranial Nerve VIII symptoms: tinnitus, hearing loss, dizziness, and vertigo

Eighth cranial nerve dysfunction may result in hearing loss or tinnitus if the cochlear division is involved, or dizziness/vertigo if the vestibular division is involved. Any patient with any of these four symptoms needs to first undergo an in office hearing examination including the Weber and Rinne test⁸, along with a Dix Hallpike maneuver to evaluate for vertigo⁹, after which it should be possible to categorize the patient into one of the following categories to decide whether imaging is necessary and, if so, which imaging study to order:

Isolated subjective tinnitus

Subjective tinnitus is an abnormal sound heard by the patient that the examiner does not hear, and is a frequently encountered symptom¹⁰. If the symptom is truly isolated, no imaging is probably necessary unless the patient is young and there is a suspicion of multiple sclerosis, in which case MR is advised.

Isolated objective tinnitus

Objective tinnitus, in which both the patient and the examiner detect the abnormal noise, is considerably less common than subjective tinnitus¹¹ and is most frequently caused by vascular lesions associated with turbulent or high velocity flow, for example around atherosclerotic plaque or through a vascular malformation. Brain MRI should be performed in patients with objective tinnitus, along with MRA or CTA of the skull base and neck vessels.

Isolated conductive hearing loss

Conductive hearing loss is caused by abnormality of the external auditory canal, tympanic membrane, ossicles, or cochlea (those structures which conduct sound to the 8th cranial nerve endings within the cochlea). Common causes include cholesteatomas, otosclerosis, and congenital abnormalities of the cochlea. Isolated conductive hearing loss does not necessarily require imaging, particularly if there is an obvious cause. When imaging is necessary, temporal bone CT is the study of choice, since it delineates the bony structures of the temporal bone much better than MR.

Isolated sensorineural hearing loss

In general, neural (8th cranial nerve or central nervous system) hearing loss is more likely to be caused by a life threatening abnormality (e.g. brain tumor) than is sensory (caused by inner ear abnormality) hearing loss¹², but the two may be difficult to distinguish. In cases of apparent neural abnormality or where there are ambiguous findings, MRI done without and with contrast with thin cuts is recommended to exclude vestibular schwannoma (formerly known as acoustic neuroma), brainstem stroke, and multiple sclerosis.

Dizziness and vertigo

Dizziness must first be distinguished from vertigo, which may be quite difficult given patients' tendencies to describe the symptoms similarly¹³. If the clinical history and Dix Hallpike maneuver implicate vertigo and the patient has any other symptom indicating a central process such as diplopia, dysarthria, dysphagia, weakness, or numbness⁹ then MRI without and with contrast material with thin cuts through the posterior fossa is recommended. Even without these features, if the vertigo does not show rapid clinical improvement, imaging is probably indicated. Patients with balance and/or gait difficulties (whether dizzy or not), particularly when accompanied by other neurologic symptoms or findings, should undergo MR to search for a causative lesion (Figure 4).

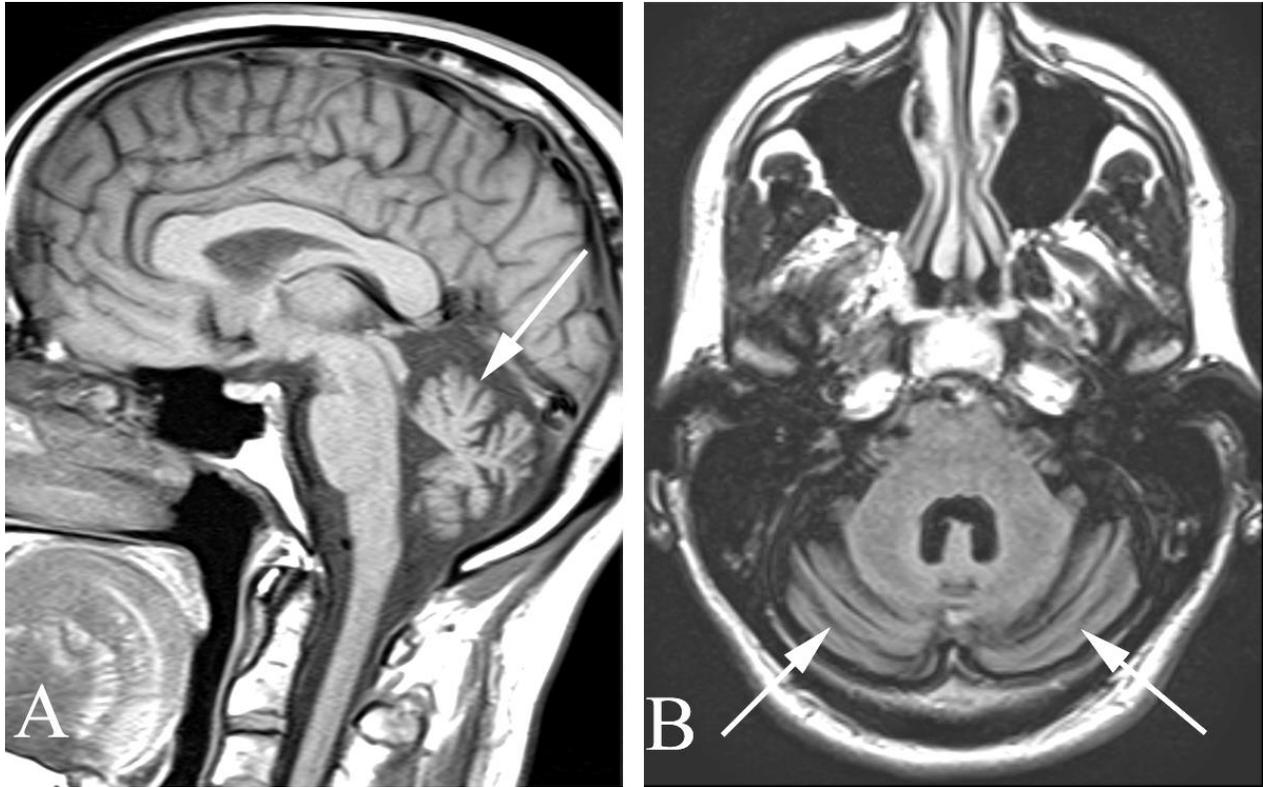


Figure 4. Cerebellar atrophy in a 36 year old man with balance difficulties and slurred speech. A. Sagittal T1 weighted MR shows loss of volume of the cerebellum (arrow). B. Axial T1 weighted image demonstrates bilaterally enlarged cerebellar sulci, compatible with cerebellar atrophy (arrows). The patient was a former alcoholic.

Mixed symptoms

If tinnitus, hearing loss, or vertigo is accompanied by any additional cranial nerve symptoms, headache, gait or coordination abnormality or other symptom suggesting a posterior fossa abnormality, MRI should be obtained to evaluate for vestibular schwannoma (Figure 5), stroke (see Chapter 4, Figure 6, page 49), brainstem tumor (Figure 6) or cerebellar tumor (Figure 7).

Cranial Nerves IX – XII symptoms: swallowing difficulty

Swallowing difficulty secondary to abnormalities of cranial nerves IX – XII may represent a stroke, and appropriate imaging needs to be performed when this is suspected (see pages 47-49). For a discussion of oropharyngeal dysphagia, see pages 98-99.

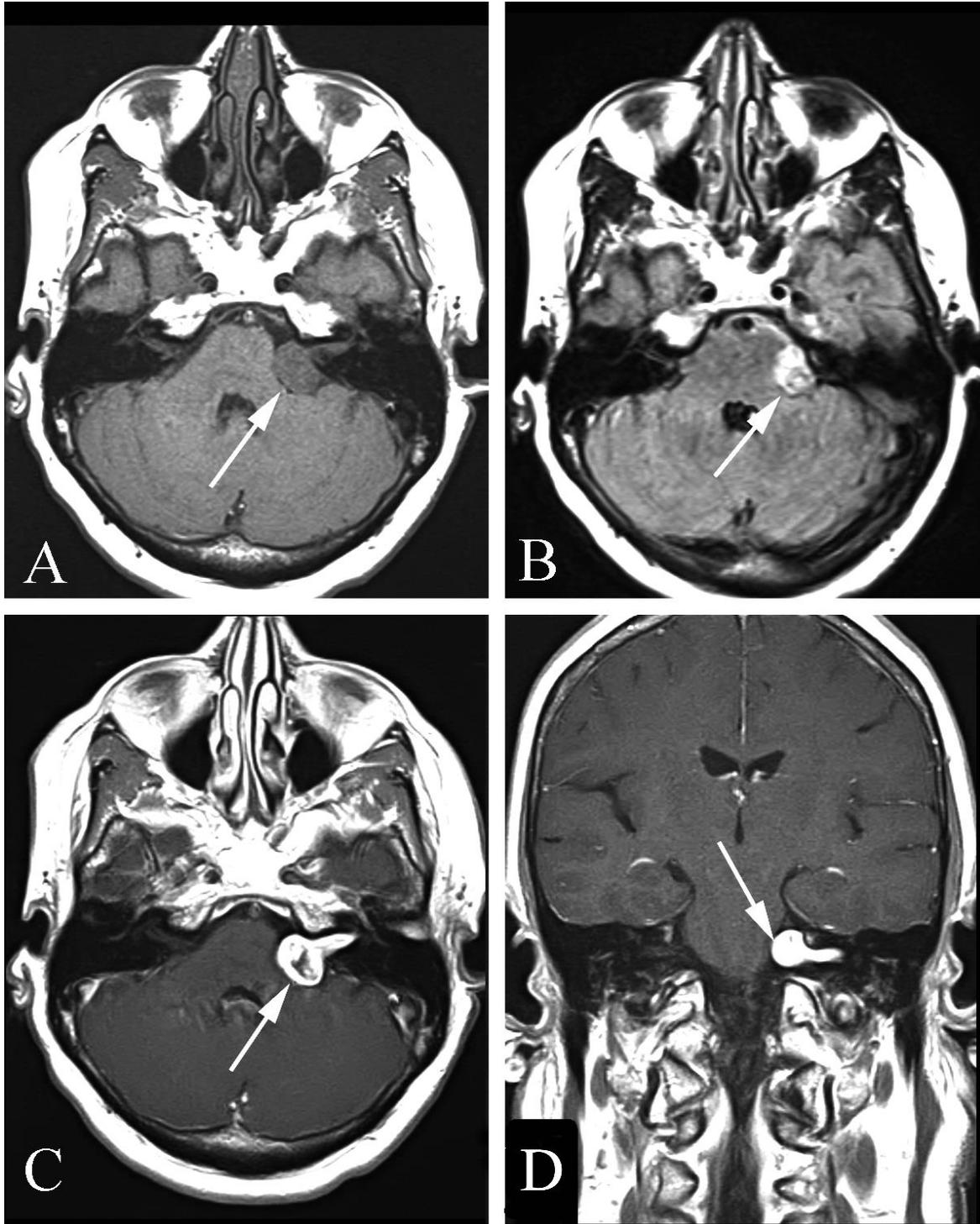


Figure 5. Vestibular schwannoma in a 55 year old woman with sensorineural hearing loss, tinnitus, and headache. A. Axial T1 weighted MR shows a cerebellopontine angle extra-axial lesion (arrow) which shows slightly decreased signal intensity relative to the adjacent brain. B. Axial FLAIR MR image demonstrates increased signal in the lesion (arrow) compared to the adjacent brain. C. Axial postcontrast T1 weighted image demonstrates the typical “ice-cream cone” appearance of the left vestibular schwannoma, with intense contrast enhancement particularly around the peripheral aspect of the tumor (arrow). D. Coronal postcontrast T1 weighted image also shows the “ice-cream cone” appearance and extension of abnormal contrast enhancement along the course of the vestibular-cochlear nerve in the internal auditory canal.

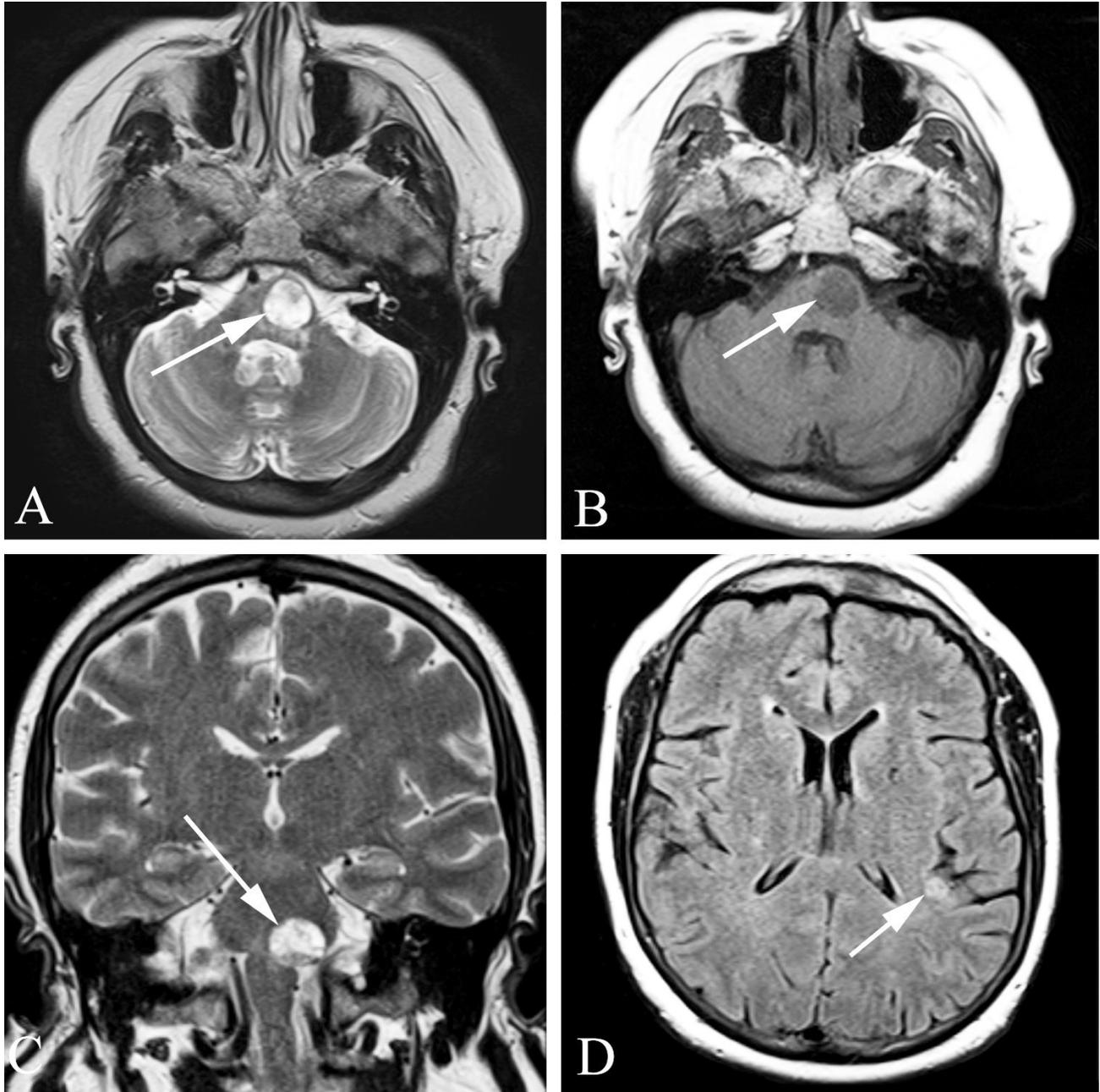


Figure 6. Metastatic disease in a 45 year old woman with tinnitus and headache who had a renal transplant. A. Axial T2 weighted MR image of the brain shows a mass with mixed (mostly increased) signal in the left brainstem (arrow). B. Axial T1 weighted image also shows the mass, with decreased signal. C. Coronal T2 weighted MR study also shows the brainstem mass. D. Axial FLAIR MR image demonstrates an additional lesion of the left cerebral hemisphere (arrow). Initially, the main consideration was for multiple brain abscesses in this immunocompromised renal transplant patient. Further study shows no extensive systemic findings of infection, however, and the patient was found to have a small cell carcinoma of the lung.

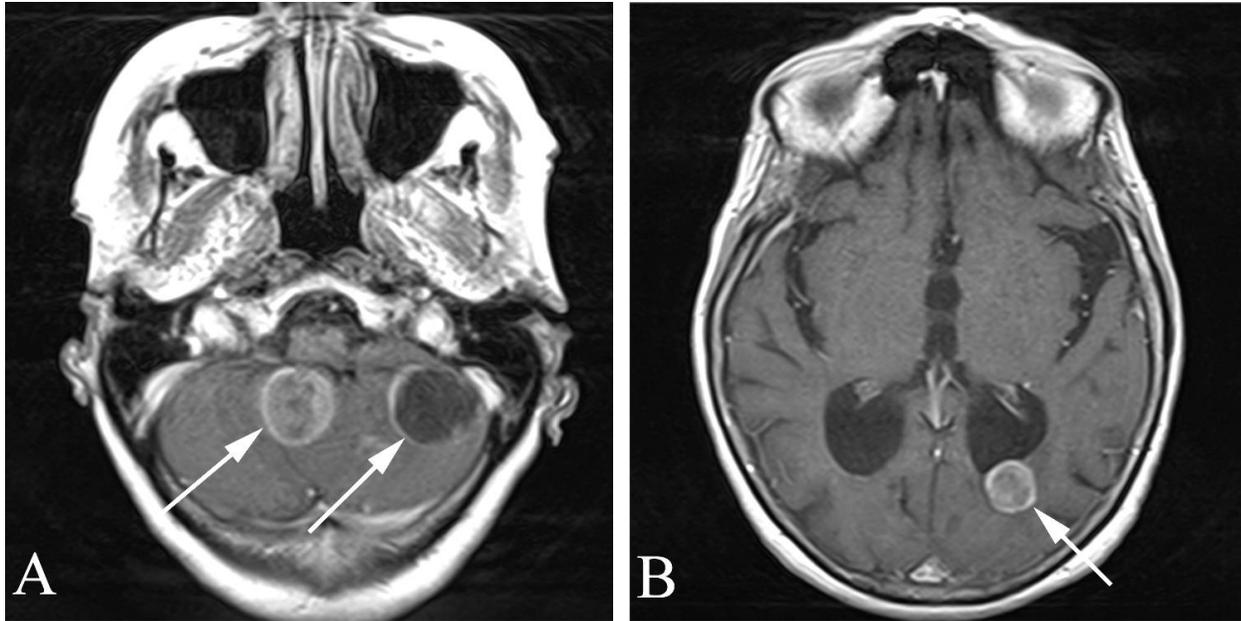


Figure 7. Metastatic disease in an 82 year old woman with balance difficulty, mental status changes, and vomiting. A. Axial contrast-enhanced T1 weighted MR exam demonstrates two separate lesions of the cerebellum (arrows), with the more midline lesion demonstrating relatively uniform contrast enhancement and the lesion of the left cerebellar hemisphere showing peripheral contrast enhancement. B. Axial contrast-enhanced T1 weighted MR exam shows an additional metastatic deposit in the left occipital lobe adjacent to the occipital trigone (arrow). The patient had known lung cancer.

PATIENTS WITH SYMPTOMS OF SINUSITIS USUALLY DO NOT REQUIRE IMAGING - CT IS THE STUDY OF CHOICE WHEN IMAGING IS NECESSARY

A diagnosis of sinusitis is based on purulent discharge and nasal congestion and/or facial pain/pressure¹⁴. It is not possible to tell from patient symptoms whether the patient has acute viral rhinosinusitis (AVRS) or acute bacterial rhinosinusitis (ABRS), although current recommendations favor supportive care rather than antibiotic treatment even for ABRS in the absence of severe pain or a temperature of over 101 degrees F (38.3 degrees C)¹⁰.

Imaging of patients with a clinical diagnosis of acute sinusitis is not typically required or helpful, as many asymptomatic, healthy individuals have sinus abnormalities also seen in sinusitis¹⁵, imaging cannot distinguish AVRS from ABRS¹⁰, and imaging (even CT) does not, in general, correlate with the severity of the disease¹⁶. Plain films are both insensitive and

nonspecific compared to CT studies in evaluation of sinusitis¹⁰.

CT of the sinuses benefits patients with sinusitis symptoms in the following special circumstances:

1. When it may be helpful to *refute* sinusitis as the cause of pain. A normal CT supports a diagnosis such as allergy, non-allergic rhinitis, and atypical facial pain (as opposed to AVRS or ABRS) in a patient with equivocal symptoms¹⁰.
2. When superimposed symptoms suggest complicated sinusitis. These symptoms include acutely diminished visual acuity, diplopia, periorbital edema, severe headache, and altered mental status¹⁷. The purpose of CT in these cases is to exclude extension of infection outside the sinuses (Figure 8) or alternative diagnoses presenting as sinusitis.
3. For mapping in cases where functional endoscopic sinus surgery (FESS) is contemplated¹⁸. In explanation: FESS was developed as a less invasive alternative to standard operations. In the classic standard surgical treatment for sinusitis, the Caldwell-

Luc procedure, the surgeon strips the mucosal lining from the sinus and opens the medial wall of the maxillary sinus to the anterior aspect of the inferior meatus in the nasal vault. Unlike the Caldwell-Luc procedure, FESS restores normal mucociliary transport by clearing obstructions to mucus flow, particularly along the maxillary infundibulum, nasofrontal duct, and ostiomeatal unit. Performance of this directed surgery depends upon^{14,19}:

- A. Obtaining a map of the exact location and cause of any obstructive process. This entails a sinus CT either performed in, or reformatted in, the coronal plane to best visualize the maxillary infundibulum, nasofrontal duct, and ostiomeatal unit (Figure 9).
- B. Knowledge of any anatomic variants that may represent a hazard if not known. Given the endoscopic nature of the surgery, it is necessary to know about such anatomic variants as dehiscence in

the lamina paprcea (Figure 10) and sphenoid sinus walls (Figure 11) to avoid inadvertent puncture of the orbit or intracranial internal carotid artery. CT also provides this.

In cases where CT is performed, Harnsbarger¹⁴ has noted that most patients can be classified into one of the following categories:

1. 40% have a normal study. As noted above, in the presence of sinusitis symptoms, a normal study supports the diagnosis of allergic sinusitis, non-allergic rhinitis, or atypical facial pain.
2. 30% had abnormalities that fit no specific pattern (sporadic, nonobstructive disease).
3. 30% had abnormalities that fit into a specific (nonsporadic) inflammatory pattern, where FESS should provide benefit. Subsets of this group include those with a maxillary infundibular pattern, a nasofrontal pattern, and an ostiomeatal unit pattern (Figure 9).

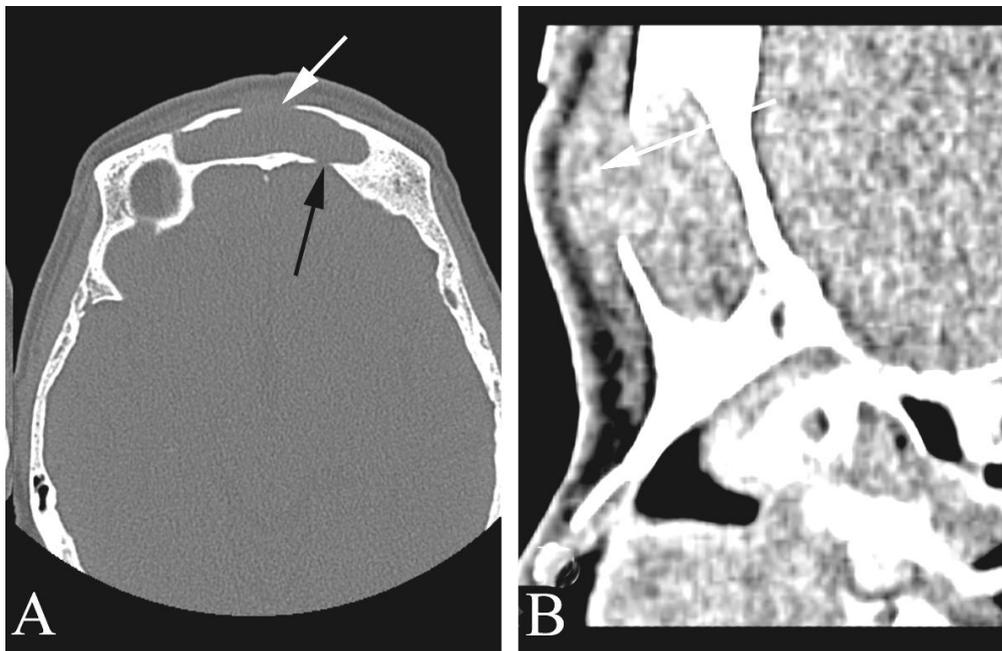


Figure 8. Sinusitis with extension of disease outside of the sinuses in a 77 year old with nasal drainage, headache, and a swollen forehead. A. Axial unenhanced head CT (bone windows) shows complete opacification of the frontal sinus as well as destruction of the anterior wall (white arrow) and posterior wall (black arrow) of the sinus. B. Sagittal reformatted CT image (soft tissue window) shows destruction of the anterior wall of the sinus with soft tissue extending anterior to the frontal bone (arrow) accounting for the patient's swollen forehead. This lesion is also known as "Pott's puffy tumor".

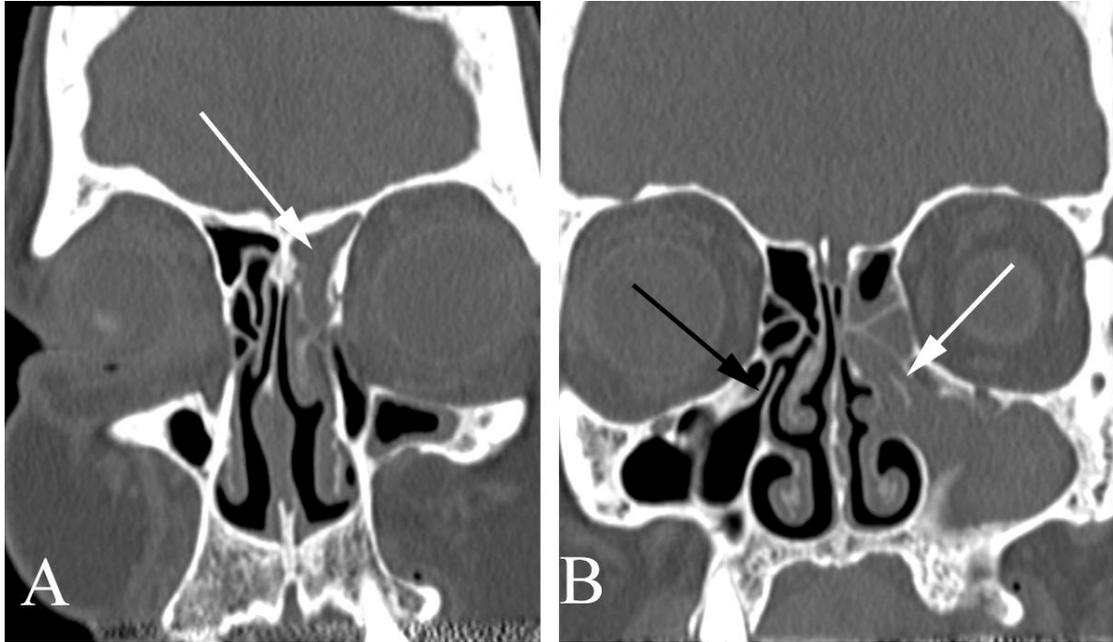


Figure 9. Sinusitis demonstrating an “ostiomeatal unit” pattern of infection in a 76 year old with chronic headache and nasal drainage. A. Coronal sinus CT (bone windows) shows opacification of left ethmoidal air cells (arrow). B. Coronal sinus CT (bone windows) at a more posterior location shows opacification of the left maxillary sinus including complete occlusion of the ostiomeatal unit (white arrow). Note the normal, open appearance of the contralateral ostiomeatal unit (black arrow).

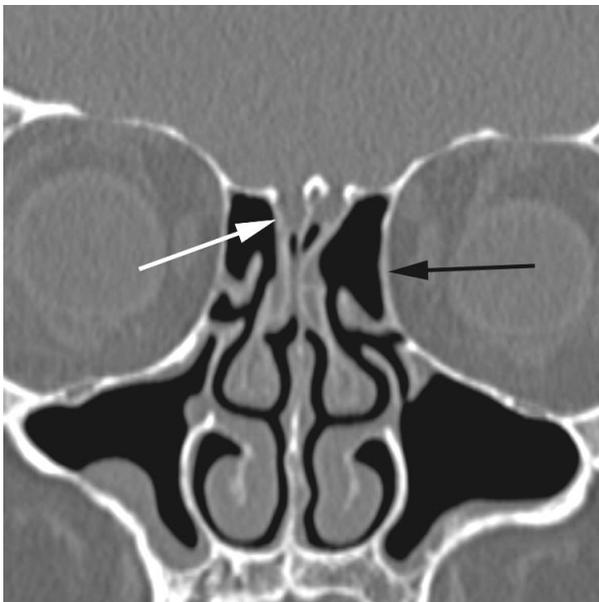


Figure 10. Possible hazards to functional endoscopic sinus surgery in a 64 year old woman with recurrent sinusitis symptoms. Coronal CT study (bone windows) shows a low-lying cribriform plate with a thin bony covering (white arrow) as well as a thin bony lamina papricea (black arrow).



Figure 11. Possible hazard to functional endoscopic sinus surgery in a 57 year old woman with recurrent sinusitis. Axial CT study (bone windows) shows a thin bony covering over the carotid canal (arrow), which protrudes into the sphenoid sinus.

PALPABLE THYROID LESIONS CAN UNDERGO FNAB WITHOUT IMAGING WHEREAS NON THYROID NECK MASSES IN ADULTS TYPICALLY REQUIRE CT SCANNING

The first step in evaluation of a neck mass in adults requires distinction between thyroid lesions and lesions outside the thyroid gland. If it is not possible to make this distinction on clinical grounds, ultrasound may be performed.

Thyroid lesions

Many patients have thyroid lesions, and while most of these lesions are benign, it is not possible to say with acceptable accuracy which lesions are benign and which are malignant on the basis of clinical examination alone. While both nuclear medicine and ultrasound have been (and can be) used for evaluation of such lesions, imaging features are not sufficiently accurate to make the distinction between benign and malignant lesions, either: solid, mixed solid and cystic, and even apparently purely cystic lesions on ultrasound examination may be malignant²⁰. It is more cost effective to obtain a fine needle aspiration biopsy (FNAB) of thyroid lesions than it is to perform imaging¹⁶. Biopsy results generally fall into one of four categories: nondiagnostic, requiring either repeat biopsy or excision of the nodule; benign, requiring at most follow-up; suspicious or indeterminate, typically requiring surgical excision; and malignant, requiring excision.

For thyroid lesions that are evaluated at ultrasound (which may or may not be palpable), current recommendations include biopsy of lesions greater than 15 mm unless microcalcifications are identified, in which case biopsy of lesions greater than 10 mm is recommended²¹.

Nonthyroid neck masses

Adult neck masses outside the thyroid gland, particularly those in patients over the age of forty and with known risk factors such as smoking, must be considered malignant until proven otherwise.

These patients typically need referral to an otolaryngologist for treatment²². While such clinical features as a soft, rubbery consistency and mobility favor a benign cause (compared to hard, fixed lesions), these clinical features are not, in themselves, diagnostic. Note that pediatric neck masses have a different set of considerations, and often represent benign cystic lesions or hemangiomas.

Almost all adult neck masses of unknown origin require a CT scan performed with contrast and extending from the arch of the aorta through the skull base (often called a “neck” or “soft tissue neck” or “head and neck” CT) (Figure 12). A marker should be placed on the lesion by the technologist performing the scan; if the patient cannot locate the lesion for the technologist, it is helpful for the primary care practitioner to mark the lesion with indelible ink prior to sending the patient for imaging so that a marker can be placed at the appropriate location. A CT of the chest may be performed at the same time, particularly if there are risk factors such as smoking, given the fact that chest primary tumors may either co-exist with neck primary tumors or be a source of metastatic deposit to the neck¹⁸. The CT may rarely suggest a cyst as may be seen with congenital/developmental anomalies such as branchial cleft cysts (Figure 13) or even provide a specific histologic diagnosis (Figure 14). However, the main purpose of the CT study is to demonstrate the exact location of the lesion, demonstrate any other nonpalpable lesions, and to search for a primary tumor, since many palpable lesions of the neck represent metastatic deposit from oropharyngeal mucosa primary tumors (Figure 12). The location of the palpable abnormality may provide a clue to the location of the primary tumor, as tumor cell drainage follows a typical pattern: for example, the lower lip, floor of the mouth, and apex of the tongue drain into the submental lymph nodes²³. Knowledge of this pattern helps the radiologist and the otolaryngologist search the associated mucosal surface for primary tumors. Otolaryngologists will typically perform laryngoscopy and both esophagoscopy and bronchoscopy may also be necessary to identify the primary lesion¹⁸. Unfortunately, even with the location of the primary lesion and knowledge of the typical spreading pattern, the primary lesion may

not be found on CT or endoscopy, in which case an FNAB of the palpable lesion is performed. If the lesion is malignant when no primary tumor has been found, random biopsy of the nasopharynx,

palatine tonsils, and base of the tongue may be performed¹⁸.

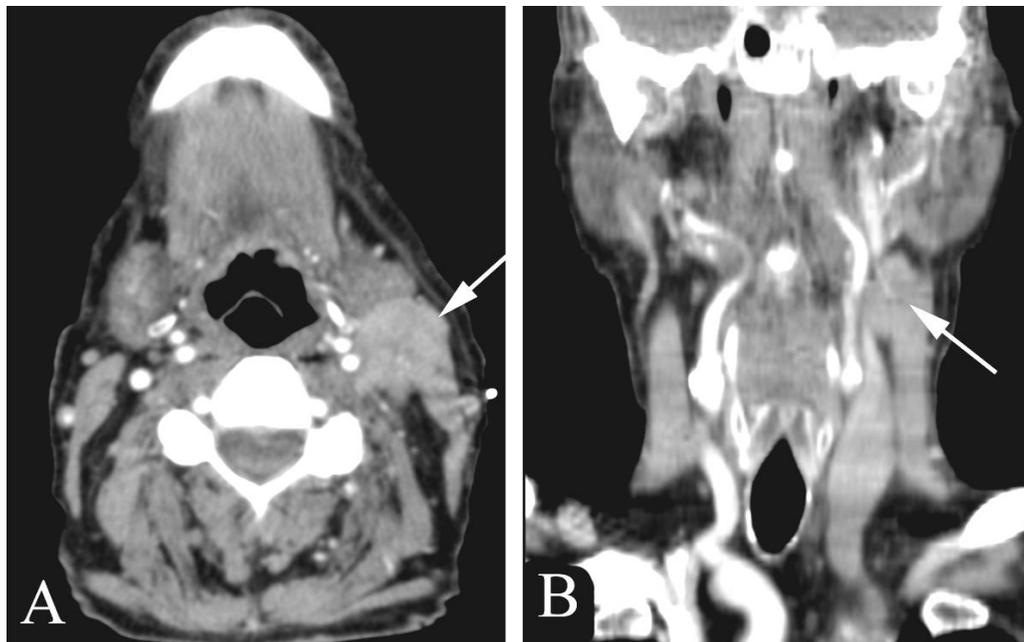


Figure 12. Metastatic squamous cell cancer of the head and neck in a 74 year old man with a palpable neck mass. A. Axial contrast-enhanced neck CT shows a mass (arrow) superficial to the carotid vessels in the left neck, representing metastatic deposit to lymph nodes. Note the marker (white dot) placed along the margin of the palpable lesion by the technologist. B. Coronal reformatted contrast-enhanced CT shows the mass (arrow) superficial to the carotid vessels.

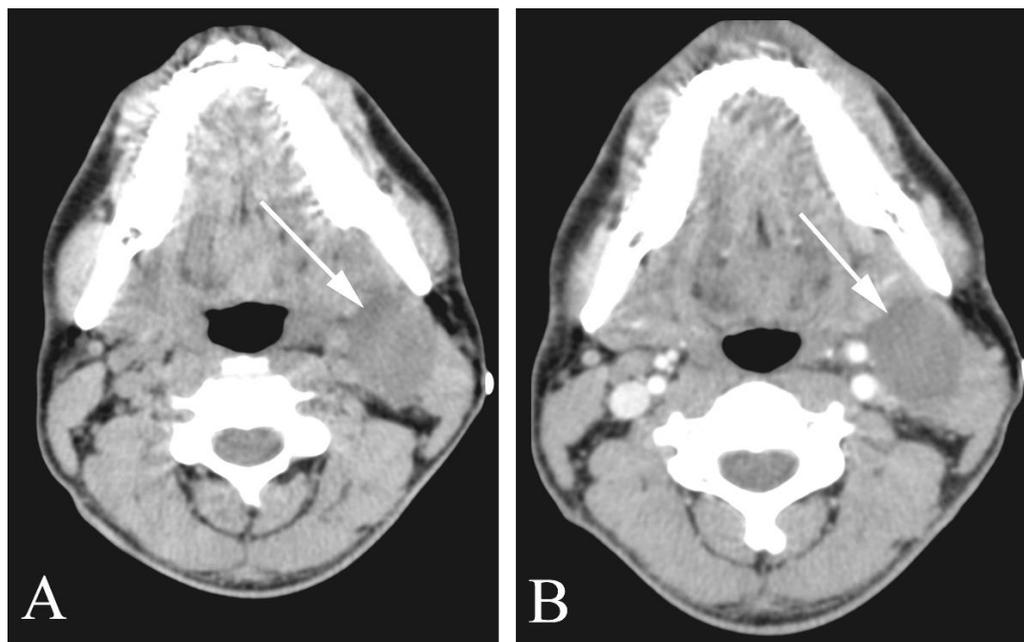


Figure 13. Branchial cleft cyst in a 32 year old man with a palpable neck mass. A. Axial noncontrast enhanced neck CT shows a mass superficial to the carotid artery and posterior to the mandible (arrow). B. Axial contrast-enhanced neck CT shows a lack of contrast enhancement of the lesion, which proved to be a branchial cleft upon removal.

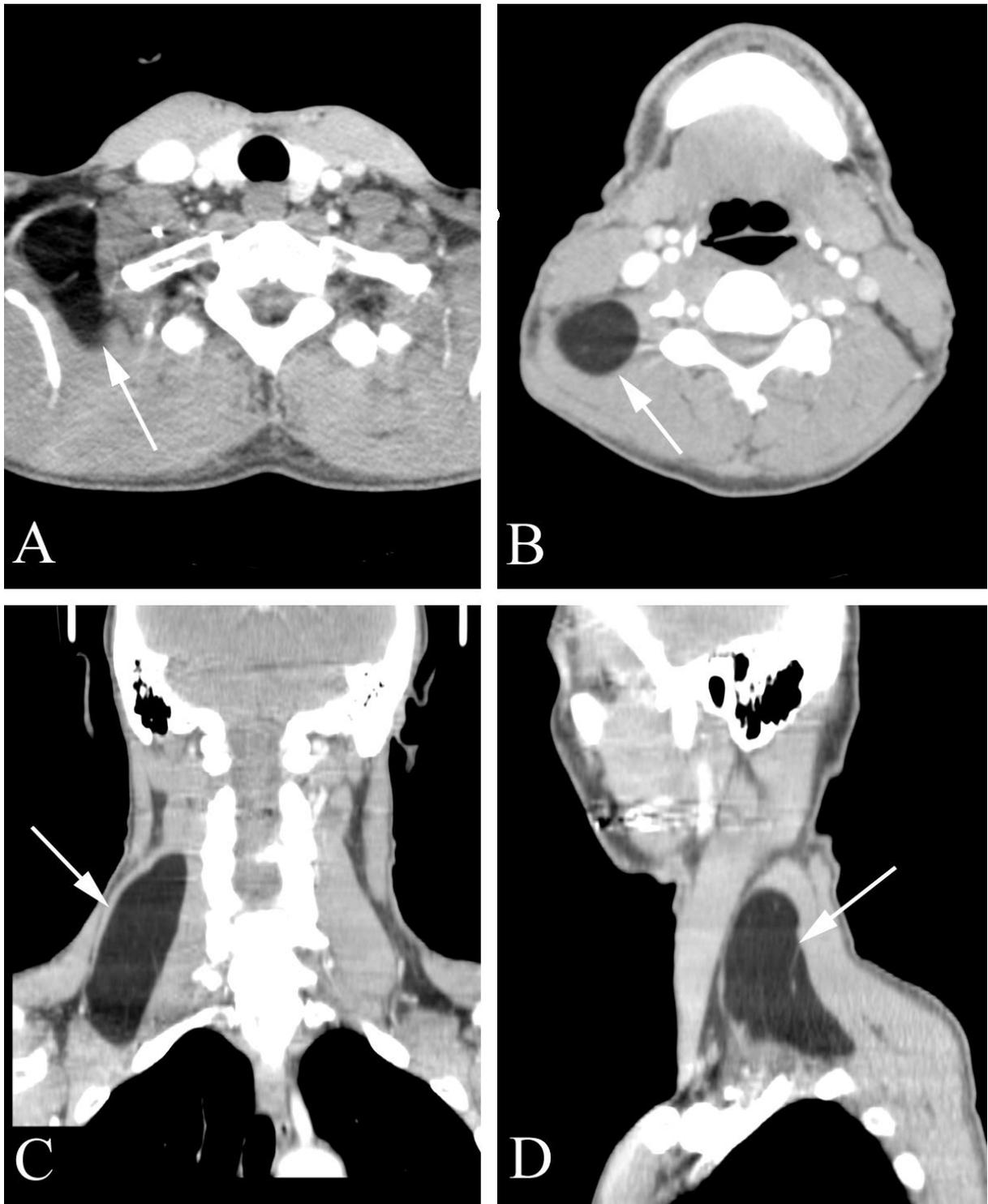


Figure 14. Benign lipoma in a 62 year old man with a palpable neck mass. A. Axial contrast-enhanced CT at the level of the thyroid gland shows a triangular soft tissue mass of fat density (arrow) in the right neck. B. Axial contrast-enhanced CT at the level of the aryepiglottic folds shows extension of the mass (arrows) superiorly, where it lies behind the sternocleidomastoid muscle (which is rotated slightly compared to the contralateral, normal side). C. Coronal reformatted contrast-enhanced CT study shows the lipoma (arrow) along the right neck, lateral to the spine. D. Sagittal reformatted contrast-enhanced CT shows the lipoma (arrow) posterior to the sternocleidomastoid muscle.

SUMMARY

Most patients with isolated cranial nerve symptoms do not require imaging, but when symptoms suggest multiple cranial nerves or a central process, brain MR should be performed. Uncomplicated sinusitis usually does not require imaging. CT of the sinuses may be performed to document sinusitis or prior to functional endoscopic sinus surgery (FESS). In patients with symptoms of complications from sinusitis orbit or head CT or MRI may be necessary. Palpable thyroid lesions can usually safely undergo percutaneous fine needle aspiration biopsy without imaging. Neck masses which do not arise from the thyroid usually require CT for evaluation.

REFERENCES

- ¹ Mann NM, Lafreniere D. Evaluation and treatment of taste and smell disorders. UpToDate, accessed 10/10/09.
- ² The Amaurosis Fugax Study Group. Current management of amaurosis fugax. *Stroke* 1990; 21:201-208.
- ³ Colby K. Vision, Blurred. Chapter in Porter RS (Editor) *The Merck Manual of Patient Symptoms*, Merck & Company, Inc, Whitehouse Station, NJ 2008.
- ⁴ Snyder PJ. Causes, presentation, and evaluation of sellar masses. UpToDate, accessed 11/2/09.
- ⁵ Bienfang DC. Overview of diplopia. UpToDate, accessed 10/10/09.
- ⁶ Pruitt AA. Management of tic douloureux (trigeminal neuralgia). Chapter 176 in Goroll AH and Mulley AG (editors) *Primary Care Medicine: Office Evaluation and Management of the Adult Patient*, 6th edition, Lippincott Williams & Wilkins, Philadelphia, 2009.
- ⁷ Pruitt AA. Approach to the patient with Bell's palsy (idiopathic facial mononeuropathy). Chapter 175 in Goroll AH and Mulley AG (editors) *Primary Care Medicine: Office Evaluation and Management of the Adult Patient*, 6th edition, Lippincott Williams & Wilkins, Philadelphia, 2009.
- ⁸ Weber PC. Evaluation of hearing loss in adults. UpToDate, accessed 10/10/09.
- ⁹ Furman JM, Barton J. Evaluation of vertigo. UpToDate, accessed 10/10/09.
- ¹⁰ Dinnes EA. Pathogenesis and diagnosis of tinnitus. UpToDate, accessed 10/10/09.
- ¹¹ Dinnes EA. Pathogenesis and diagnosis of tinnitus. UpToDate, accessed 10/10/09.
- ¹² Ruben RJ. Hearing loss. Chapter in Porter RS (Editor) *The Merck Manual of Patient Symptoms*, Merck & Company, Inc, Whitehouse Station, NJ 2008.
- ¹³ Tucci DL. Dizziness and vertigo. Chapter in Porter RS (Editor) *The Merck Manual of Patient Symptoms*, Merck & Company, Inc, Whitehouse Station, NJ 2008.
- ¹⁴ Hwang PH, Betz A. Acute sinusitis and rhinosinusitis in adults. UpToDate, accessed 10/10/09.
- ¹⁵ Havas TE, Motbey JA, Gullane PJ. Prevalence of incidental abnormalities on computed tomographic scans of the paranasal sinus. *Arch Otolaryngol Head Neck Surg* 1988; 114:856-859.
- ¹⁶ Shields G, Seikaly H, LaBoeuf et al. Correlation between facial pain or headache and computed tomography in rhinosinusitis. *The laryngoscope* 2009; 13:943-945.
- ¹⁷ Osguthorpe JD, Hadley JA. Rhinosinusitis. Current concepts in evaluation and management. *Med Clin North Am* 1999; 83:27-41.
- ¹⁸ Harnsberger HR. Sinonasal imaging: imaging issues in sinusitis. Chapter 15 in: *Harnsberger HR. Handbook of Head and Neck Imaging*, 2nd edition, Mosby, St. Louis, MO, 1995.
- ¹⁹ Grossman RI, Yousem DM. Sinonasal disease. Chapter 13 in Grossman RI, Yousem DM, *Neuroradiology: The Requisites*, Mosby, Philadelphia, 2003.
- ²⁰ Slovik DM. Evaluation of thyroid nodules. Chapter 95 in Goroll AH and Mulley AG (editors) *Primary Care Medicine: Office Evaluation and Management of the Adult Patient*, 6th edition, Lippincott Williams & Wilkins, Philadelphia, 2009.
- ²¹ Frates MC, Benson CB, Charboneau JW et al. Management of thyroid nodules detected at US: Society of Radiologists in Ultrasound consensus conference statement. *Radiology* 2005; 237:794-800.
- ²² Fried MP. Neck Mass. Chapter in Porter RS (Editor) *The Merck Manual of Patient Symptoms*, Merck & Company, Inc, Whitehouse Station, NJ 2008.
- ²³ Lin D, Deschler DG. Evaluation of a neck mass. UpToDate, accessed 10/10/09.