

The diagnosis of sinusitis in infants and children: X-ray, computed tomography, and magnetic resonance imaging

Diagnostic imaging of pediatric sinusitis

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Plain film radiographic examination, the historical standard, is rapidly being supplanted by computed tomography (CT) and magnetic resonance imaging (MRI) in the diagnosis of sinusitis. In particular, many endoscopic surgeons consider CT to be a mandatory part of the preoperative evaluation. MRI is useful for cases complicated by orbital or intracranial extension. However, because of considerations of cost, the need for sedation, and for CT radiation exposure, conventional x-ray films will continue to play an important role in the diagnosis and management of medically treated sinus disease. Incidental sinus abnormalities in children without apparent symptoms are usually the result of resolving, uncomplicated upper respiratory tract infection. Opacification, moderate-to-severe mucosal thickening, or air fluid levels in patients with persistent symptoms indicate sinusitis. Sinus imaging in children, whatever the modality, is demanding both in obtaining technically adequate studies and interpreting findings. Poor-quality examinations usually overestimate the presence and severity of disease. Ideally, children should be referred to centers with expertise in pediatric ear, nose, and throat imaging. (J ALLERGY CLIN IMMUNOL 1992;90:442-4.)

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The maxillary and ethmoid sinuses are present and may be normally aerated at birth.^{1, 2} Pneumatization of the sphenoid is usually detectable at about 3 years of age³ and progresses throughout childhood. The frontal sinuses first extend above the roofs of the orbits at about 5 years but may remain hypoplastic or aplastic into adulthood.¹

INCIDENTAL SINUS OPACIFICATION IN INFANTS AND CHILDREN

The high prevalence (30% to 50%) of incidental sinus opacification in infants and children without apparent symptoms has been documented by x-ray film studies^{4, 5} and confirmed by computed tomography (CT).^{2, 6} Some authors have ascribed this finding to crying during radiographic examinations or even stated that it may represent the normal condition in

infants and young children.⁷ A recent study suggests that most asymptomatic sinus opacification in children older than 1 year is actually secondary to apparently uncomplicated upper respiratory tract infection. These findings may persist as long as 2 weeks after symptoms have resolved.⁸

Since the introduction of magnetic resonance imaging (MRI), it has become evident that a significant number of incidental sinus abnormalities also occur in adults. Mucosal thickening of more than 3 mm depth, cysts, polyps, or air-fluid levels may be found in 10% to 20% of patients referred for MRI of the brain.⁹⁻¹¹ As in children, these abnormalities may be from subclinical or resolving respiratory infections and allergy. The frequency of these findings should not lead to a nihilistic attitude toward the diagnosis of sinusitis in patients who have been selected for imaging on the basis of their clinical signs and symptoms.

DIAGNOSTIC MODALITIES

Plain film (conventional x-ray)

X-ray examination has been the mainstay of diagnosis of sinusitis in children and adults, although in

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recent years the benefits and markedly improved sensitivity and specificity of cross-sectional imaging techniques such as CT and MRI have become evident.¹²⁻¹⁴ The basic X-ray examination of the paranasal sinuses includes three films: the Water's (occipitomental), which is primarily useful for the evaluation of the maxillary and frontal sinuses; the Caldwell (angled posteroanterior), which is the only projection that gives information about the ethmoid air cells, and the lateral view, which is primarily of value for evaluating adenoid size, nasopharyngeal masses, and sphenoid disease. However, it should be kept in mind that plain films are insensitive for sphenoidal abnormalities. Evaluation of this sinus almost always requires cross-sectional imaging.

Additional views such as the base (submentovertex) and Towne's (occipitofrontal) are sometimes obtained but have a low diagnostic yield in children.¹² The Water's projection is often requested as a single view to "rule out sinusitis" based on the now discredited notion that the absence of maxillary sinus abnormality excludes the possibility of significant sinus disease. Limited one- or two-view examinations may be useful in the follow-up of patients with previously diagnosed sinusitis.

The number and types of views obtained in plain film examinations is often a source of friction between referring physicians and radiologists. It is best to consult with a radiologist and establish an overall policy rather than simply sending patients in with prescriptions specifying particular x-ray film projections. Plain film radiography of the sinuses is technically demanding, and interpretation is difficult, especially in children. Ideally, younger patients should only be referred to hospitals or offices where there is a radiologist who has the interest and expertise in the diagnosis of pediatric sinus disease. Poor-quality radiographic examinations almost always overestimate the presence and severity of sinus abnormalities and are likely to contribute only radiation exposure and expense to the care of the child with suspected sinusitis.

The role of plain film examination in sinus disease is becoming more limited as cross-sectional techniques and nasal endoscopy are increasingly used as initial diagnostic techniques. However, these newer modalities usually require sedation in preschoolers, and endoscopy is more technically demanding than in adults because of the smaller size of the nasal airways. For these reasons, as well as those of economics and access, conventional x-ray film studies will probably continue to play an important role in the diagnosis and follow-up of many cases of medically managed sinusitis.

CT EXAMINATION OF THE PARANASAL SINUSES

Since shortly after its introduction, and especially with the increasing popularity of endoscopic surgery, CT has been widely recognized to be the standard of diagnosis for paranasal sinus disease. In particular, coronal thin-section images offer excellent delineation of lesions in the ostiomeatal complex,¹⁴ which is now felt to be the critical region in the pathophysiology of recurrent sinus disease. Axial images are useful for the evaluation of periorbital and intraorbital complications of sinusitis.¹⁵

In some institutions, a so-called screening CT of the sinuses is performed with a limited number of slices and low-dose technique.¹⁶ It can then be offered at a cost and radiation exposure competitive with plain film studies, but with much greater accuracy. Unfortunately, the suitability of this technique for infants and young children is limited by the need for sedation. Because there are gaps between CT sections, this type of examination may be inadequate for surgical planning.^{14, 17}

At our institution most infants and toddlers undergoing CT and MRI are sedated with chloral hydrate at a dose of 80 mg/kg given orally or rectally. Over the age of 2 years, or for children resistant to chloral hydrate, pentothal (Nembutal) is given as an intramuscular injection of 5 mg/kg or by slow intravenous injection of 2 to 4 mg/kg. Intravenous sedation is especially useful in MRI in which imaging times are longer and supplemental doses, if needed, can be given through an indwelling line. All patients receiving parenteral sedation are placed on pulse oximetry, given nasal oxygen, and are kept under close observation until they show signs of awakening.

Contrast injection is rarely necessary for the evaluation of benign sinus disease, although it may be of value for malignant disorders and complex infections with bone destruction and extension into the cranium or orbit. In these clinical situations, MRI is rapidly becoming the examination of choice.

MRI

MRI has many advantages in the evaluation of paranasal sinuses. It offers the best soft tissue contrast, which is especially valuable in the evaluation of neoplasms and complicated infections that extend beyond the sinuses. Also, multiplanar sections may be obtained without disturbing the patient. It is the only practical cross-sectional technique for obtaining direct sagittal scans. Images are also obtained without the use of ionizing radiation, which is particularly desirable in children.

However, MRI also has several limitations. These

include high cost, long imaging times that make sedation necessary in most children, and the inability to directly display bony landmarks, which is of particular importance to the endoscopic surgeon. Because of difficulties imposed by the long bore of the most superconducting magnets and the high strength fields, monitoring and observation of the patient are also limited. This poses a small but real risk of sedation-related complications. Even in some adults, MRI studies are not feasible because of claustrophobia.

For these reasons, MRI is usually a secondary or tertiary examination for the small number of patients with sinus neoplasms or complex infectious disorders. However, it is the study of choice for the evaluation of possible or known intracranial extension of sinus disease. In this situation its ability to obtain multiplanar images and excellent soft tissue discrimination present unique and compelling advantages, even over contrast-enhanced CT.

THE ROLE OF DIAGNOSTIC IMAGING IN THE CLINICAL MANAGEMENT OF SINUS DISEASE IN CHILDREN

Diagnostic radiology is able to offer a cornucopia of techniques that provide precise and accurate information about the presence and extent of sinus disease. The clinical problem is how best to use these tools for the patient's benefit while at the same time minimizing expense and radiation exposure. The appropriate use of sinus imaging depends primarily on the clinical presentation of the patient and the local availability of imaging modalities and expertise in their use.

If low-cost screening CT is not available, plain film examination should still be the initial imaging study in most children who have symptoms of sinus disease. An initial uncomplicated episode of sinusitis can probably be treated on the basis of the clinical findings. X-ray film studies can then be limited to those patients who have recurrent or persistent problems after appropriate medical therapy.

If clinical and radiographic abnormalities do not resolve with more intensive medical management, coronal CT should be considered. The value of this study is maximized if the patient has received the full benefit of antibiotic and decongestant therapy before the examination so that underlying obstructing lesions of the ostiomeatal complex may be separated from surrounding mucosal edema and fluid.¹⁷

Children who have periorbital swelling or proptosis should undergo immediate contrast-enhanced CT ex-

amination in both axial and coronal planes. If symptoms or CT findings suggest intracranial extension, an MRI evaluation should then be performed, assuming that this does not delay appropriate surgical management. The rare patients with malignancies or aggressive infections causing bone destruction may also require combined CT and MRI evaluation.

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