

Comparison of plain radiographs, coronal CT, and intraoperative findings in children with chronic sinusitis

RANDE H. LAZAR, MD, RAMZI T. YOUNIS, MD, and LOUIS S. PARVEY, MD, Memphis, Tennessee

Evaluating the extent of chronic sinusitis in children is critical in management of the disease and determination of the need for surgery. High-resolution computed tomography can demonstrate disease that is not shown on routine x-ray films. It can also delineate pathologic variations and demonstrate inaccessible anatomic structures. We compared plain radiographs, CT scans, and intraoperative findings for 300 pediatric patients with chronic or recurrent sinusitis. Despite an imperfect record in demonstration of sinus disease in all of our patients, computed tomography was unquestionably better than plain radiography in diagnosis of chronic sinusitis and evaluation of the need for surgery. Despite its superior performance, CT should not be used exclusively to diagnose disease or propose surgery. These determinations must be made on the basis of a combination of the patient's symptoms, physical examination findings, and CT results. (OTOLARYNGOL HEAD NECK SURG 1992;107:29.)

Sinusitis is a common disease in the pediatric age group. Diagnosis is challenging because children rarely demonstrate the common characteristics of sinusitis manifested in adults and because children can manifest different signs and symptoms at different ages.^{1,2}

Plain x-ray films of the sinuses have been the accepted standard radiographic study for diagnosis of sinus disease.³⁻⁵ However, high-resolution computed tomography (CT) is gradually diminishing the importance of plain radiographs.

We compare plain radiographs, CT scans, and intraoperative findings for 300 pediatric patients with chronic or recurrent sinusitis and discuss the role of radiographic assessment in determination of the need for surgical management.

MATERIALS AND METHODS

The charts of 300 pediatric patients with chronic or recurrent sinusitis were reviewed. Patients with persis-

tent symptoms of sinusitis for at least 3 months despite a well-proven medical treatment were considered chronic. Recurrent sinusitis was diagnosed whenever a patient had more than four episodes of acute sinusitis in a 6-month period. The ages of the children at diagnosis ranged between 14 months and 16 years.

Each patient had a coronal CT scan of the sinuses. Only half of the patients had plain x-ray films of the sinuses in addition to CT scans. Anteroposterior (Caldwell), occipitontental (Waters), and lateral views were taken. For 105 (70%) of the 150 patients who had x-ray films and CT scans, the radiographs were obtained on the same day the CT scans were performed. For the remaining 45 patients in this group, the radiographs were obtained 3 to 7 days before the CT scans.

All 300 patients had completed a 3-week course of maximal medical therapy at the time of the radiographic examination. This therapy consisted of an oral broad-spectrum antibiotic (e.g., Augmentin, Ceclor, or Cefitin), beclomethasone nasal spray (Beconase), and decongestants. All 300 patients demonstrated symptoms of chronic or recurrent sinusitis at the time of the radiographic studies. These symptoms included chronic cough, persistent anterior-posterior rhinorrhea, nasal congestion, and chronic otitis media. A history of chronic headache was elicited from these patients, even in the very young children.

The plain x-ray films were interpreted by a pediatric radiologist. The anteroposterior, occipitontental, and lateral views were considered positive for paranasal sinusitis if there was evidence of mucosal thickening or opacification or evidence of thickened polypoid mu-

From the Department of Pediatric Otolaryngology (Drs. Lazar and Younis), Le Bonheur Children's Medical Center; the Department of Otolaryngology-Head and Neck Surgery (Drs. Lazar and Younis), Methodist Hospitals of Memphis; and Diagnostic Imaging, P.C. (Dr. Parvey).

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Reprint requests: Rande H. Lazar, MD, Otolaryngology Consultants of Memphis, 777 Washington Ave., P240, Memphis, TN 38105. 23/1/37655

Table 1. Plain radiographs

Factors leading to misinterpretation
Variations in radiographic techniques
Sloping of lateral and superior maxillary sinus walls
Double contours in maxillary sinus imaging
Anatomic variations in children:
Hypoplastic maxillary sinus
Small or aplastic sinus
Slight rotation
Sinonasal secretions
Thick sinonasal mucosa

Table 2. Symptoms of pediatric patients with chronic sinusitis

Symptom	Less than 3 years	3 to 6 years	7 to 16 years
Chronic cough	++	+++	++++
Anterior-posterior rhinorrhea	+++	+++	++
Nasal congestion	+	+++	+++
Otitis media	+++	+++	++
Headache		++	+++

The number of +'s indicate the relative incidence of each symptom for the children with chronic sinusitis in each age group: + is less than ++; ++ is less than +++; +++ is less than ++++.

cosa. The same radiologist interpreted the CT scans independently of the plain radiographs. The CT scan findings included mucosal thickening or opacification of one or more sinuses, ostiomeatal complex obstruction, concha bullosa, or paradoxical middle turbinate. Operative findings were obtained from the surgical reports in the patients' charts.

The ostiomeatal complex is the key for understanding sinusitis. It is the region of the middle meatus where flow converges from the frontal, maxillary, and ethmoid sinuses. Ostiomeatal obstruction can profoundly hinder the flow of these sinuses and lead to sinusitis. Narrowing or obstruction can be caused by massive enlargement of an air cell within the middle turbinate, marked lateral convexity of the middle turbinate, enlarged bulla ethmoidalis, or marked rotation of the uncinate process.

RESULTS

Plain x-ray findings indicated chronic disease in 105 (70%) of 150 patients (Table 1). CT scans indicated chronic disease in 140 (93%) of the 150 patients who did not have plain x-ray films. The remaining 10 (7%) of the 150 patients in this group had normal CT scans.

Table 3. Correlations between clinical and radiographic findings

Symptom	Plain radiograph		CT Scan	
	Normal	Abnormal	Normal	Abnormal
Chronic cough	++	+++	+	++++
Chronic rhinorrhea	+++	+++	+	++++
Chronic otitis media	+++	+++	++	+++
Headache	++	++	+	+++

The number of +'s indicate the relative correlation of each symptom with the normal or abnormal findings on plain radiographs or CT scans: + is less than ++; ++ is less than +++; +++ is less than ++++.

In comparing the plain radiograph and CT interpretations, findings of paranasal sinusitis were discovered on the CT scans of 18 (40%) of 45 patients for whom the plain radiographs indicated no sinus disease (Fig. 1). In contrast, normal CT scans were reported for 38 (36%) of the 105 patients who had findings of sinusitis on plain x-ray films; a significant number of these false-positive results were in children younger than 3 years of age. Table 2 demonstrates the variations of clinical findings within the pediatric group subsets. Table 3 displays the correlations between radiographic and clinical findings.

A staff member of the Otolaryngology Consultants of Memphis performed functional endonasal sinus surgery (FESS) for 235 of these patients (Fig. 2). All patients who had their diagnoses confirmed by CT were found to have significant disease intraoperatively. However, 28 (20%) of 140 patients had more extensive disease intraoperatively than had been indicated by their CT scans. In most of these cases, polypoid disease was present in the frontal recess, but had not been detected by CT. Moreover, polypoid disease of the anterior ethmoid sinus was discovered to be more extensive during surgery than had been demonstrated on the CT scans in these cases (Fig. 3).

Ten patients underwent FESS despite normal findings on CT scans. The decision to proceed surgically was made on the basis of their histories and clinical manifestations. These patients had nasal discharge, persistent cough, recurrent otitis media, and headaches. All of these patients had undergone tonsillectomies and adenoidectomies and had been evaluated for allergies. Because their symptoms were significant and persistent, we decided to perform FESS. In all of these patients, extensive ethmoidal and frontal recess disease was found.

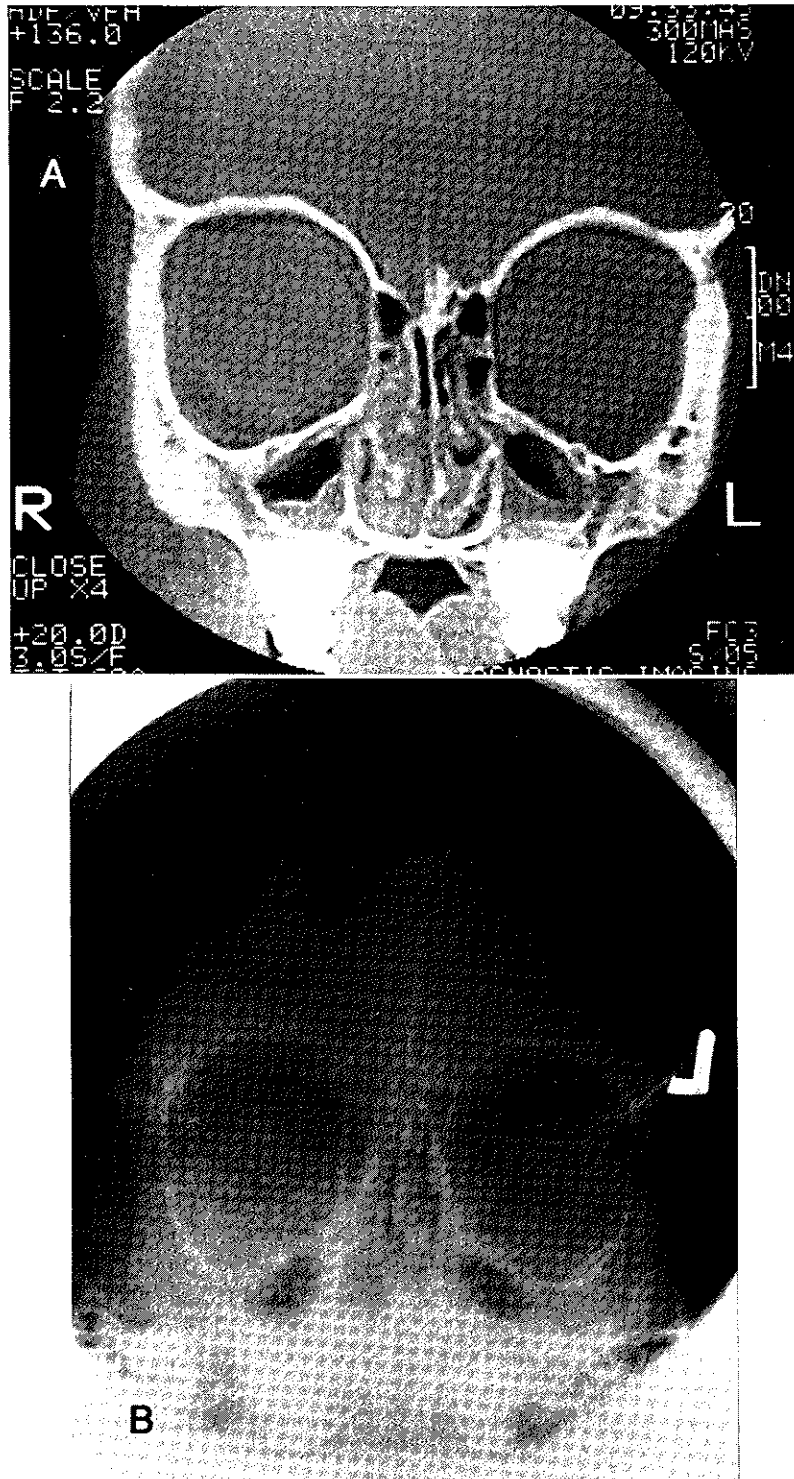


Fig. 1. A, CT scans delineate inaccessible anatomic structures and demonstrate disease not shown on B, routine x-ray films.

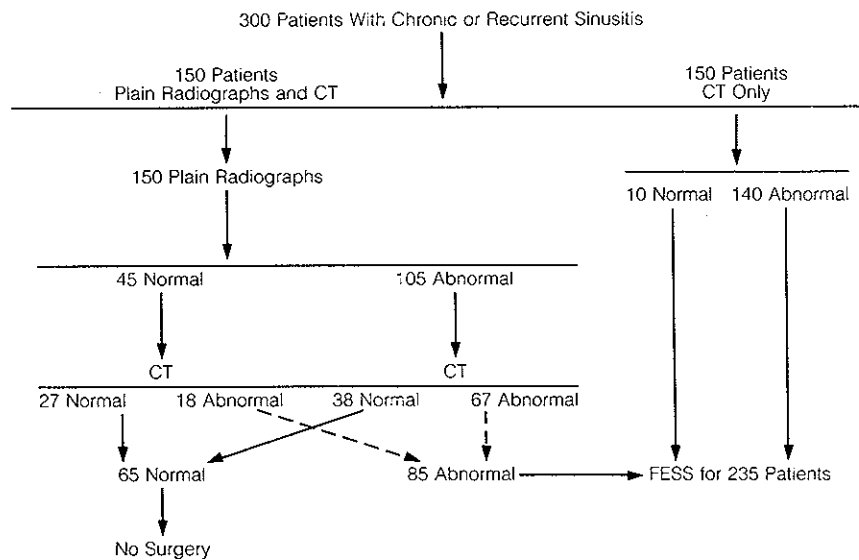


Fig. 2. Flow chart of diagnosis and treatment for 300 patients with chronic or recurrent sinusitis.

The decision to perform FESS is made on the basis of the presenting symptoms and on the CT findings. In some patients, the persistence and severity of symptoms may be the sole indication for surgery. The CT scan should not be used exclusively to diagnose chronic sinusitis, but it is the best available radiographic tool that can provide supplementary clinical data and assist in directing surgical treatment.

COMMENT

The most common modality used for substantiation of sinus disease is plain radiography. The anteroposterior view is used to visualize the frontal and ethmoid sinuses. The occipitomeatal view is used for delineation of the maxillary sinuses, and the submentovertex and lateral views are used for observation of the sphenoid sinus. However, submentovertex views are difficult to achieve in infants and young children. Air fluid levels and opacification are considered to be reliable pathologic findings on plain x-ray films.^{4,6} Some authors also consider mucosal thickening of 4 mm or more pathologic.⁴

CT scans of the sinuses have advanced the field of diagnostic radiology. Coronal CT of the sinuses with 4-mm cuts at 3-mm intervals and appropriate bone windows is proving to be the best radiographic tool for diagnosis of chronic sinusitis.⁴ CT scans can demonstrate disease that is not shown on routine x-ray films. It can also delineate pathologic variations and demonstrate inaccessible anatomic structures, such as the ostiomeatal complex.

Any modality used in treatment of sinusitis must address the ostiomeatal complex. Because the pathologic details of this critical anatomic area cannot be obtained by plain radiography, coronal CT appears to be the best radiographic modality for diagnosis of chronic sinusitis. Although, Bolger et al.⁷ raised some questions about the importance of ostiomeatal complex abnormalities and the abnormal findings on CT scans, we believe abnormalities of the ostiomeatal complex are one of the main pathologic factors in sinus disease. Narrowing or obstruction of this region can hinder appropriate drainage and aeration, resulting in sinusitis. The diagnosis usually requires CT imaging, and the correction of the abnormalities can be achieved by FESS. In all cases, a better evaluation of the exact pathology is obtained by intraoperative documentation.

Many researchers have reported the frequency of abnormal radiographic findings in asymptomatic children.^{3,5} Caffey³ advised caution in interpreting the results of the sinus radiographs of children because certain variations, such as redundant mucosa or mucosal tears in infants, may generate opacities. Caffey also suggested that asymmetry in facial bones or sinus development, overlying soft tissues, or both conditions may cause apparent differences in sinus aeration, leading to misinterpretation of plain radiographs. In our study, most of the patients who had abnormal findings on plain x-ray films but normal CT scans were infants. These findings correlated remarkably well with other studies.^{6,8,9} In contrast; Wald et al.^{4,10} indicated that abnor-

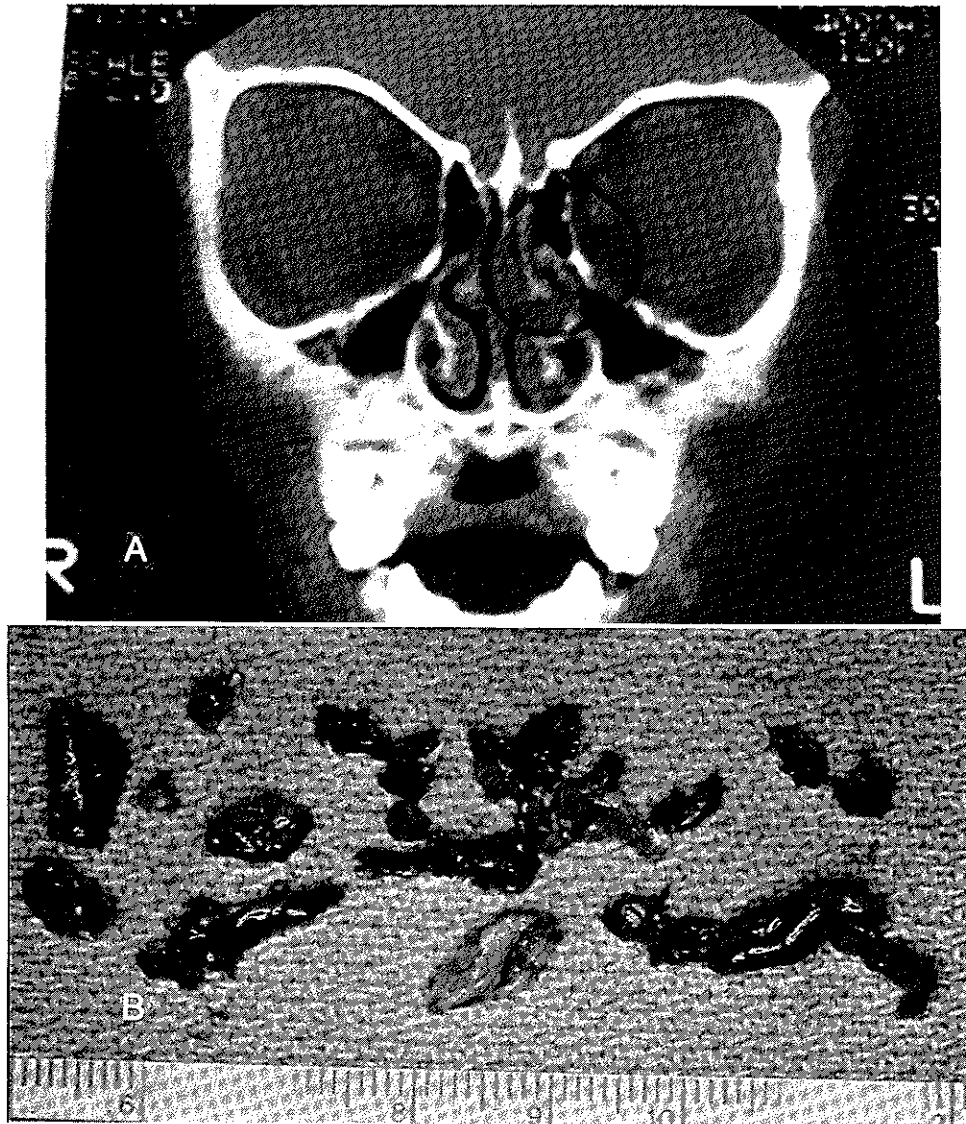


Fig. 3. A, CT scan of the sinuses shows minimal ostiomeatal complex disease on the left side. B, Polypoid tissues removed during surgery from the same side during surgery.

mal maxillary sinus radiographs were infrequent in children older than 1 year who had no symptoms or signs of respiratory tract infection.

Many factors can cause the erroneous interpretation of plain radiographs of sinuses in children (several of these factors are listed in Table 1).⁹ In reviewing the correlations among plain x-ray findings, CT results, and intraoperative reports, we concluded that plain radiographs were neither specific nor sensitive enough for the diagnosis of chronic sinusitis in children. If the diagnosis had been made on the basis of x-ray films only, 40% of the patients with sinusitis could have been

missed. Moreover, 36% of the patients would have been treated for nonexistent disease.

Chronic cough, chronic rhinorrhea, and chronic otitis media were observed in most of our population of surgical patients. The CT findings for the patients were consistent with sinusitis, and all of them had significant intraoperative findings (Table 3). Patients (28 of 140) who had intraoperative findings of disease that was more extensive than had been indicated by the CT scans had all tested positive for allergies, which emphasizes the significant pathologic role of allergy in sinus disease.

Our results indicate that high-resolution CT of the sinuses is the most sensitive and specific radiographic modality currently available for diagnosis of chronic sinusitis. This conclusion correlates quite well with the findings of McAlister et al.⁹ Despite good results, the CT scan is not an ideal radiographic tool. In 20% of the cases, more extensive disease was discovered intraoperatively than was illustrated by the CT scans, and 7% of the patients with significant disease had normal preoperative CT scans.

The findings during FESS reflect the exact pathology and remain superior to the evidence provided by CT.⁷ Direct visualization obtained by using the Storz-Hopkins telescopes and the clear illumination supplied by fiberoptic light sources allow the physician to assess the exact nature and extent of disease during surgery. Coronal computed tomography of the sinuses appears to be the best available radiographic image for the diagnosis of sinusitis, but it is only an adjunctive tool and should not be used exclusively for the diagnosis of sinusitis. The decision to perform surgery usually is made on the basis of the combined diagnostic criteria of appropriate symptoms, physical examination findings, and CT imaging results.

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