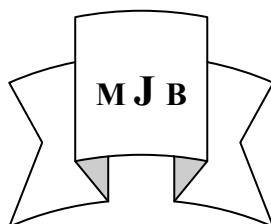


Conventional Sinus Radiography Compared with CT in the Diagnosis of Sinusitis: Prospective Study

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Abstract

Objective: To evaluate the value of plain film radiography in a prospective investigation of patients with clinical suspicion of sinusitis, in comparison with computed tomography findings .

Methods: Between October 2007 and January 2009, 100 patients with signs and or symptoms of sinusitis and did not respond to classical treatment were selected , age range 5-30years; 60 male and 40 female; each patient underwent conventional X-ray and standard dose CT examinations during the same visit. The sensitivity and specificity of the plain film and computed tomography examination were calculated

Results: The false negative results of plain x-ray was 30% in diagnosis of sinusitis ,the specificity of the plain film examination was 33%, but the sensitivity was 45% except for the maxillary sinus (sensitivity 80%). Thus, for maxillary sinusitis, plain film examination was reasonably accurate. A negative finding in the other sinuses could not be relied upon.

While the false negative results of computed tomography was 2% for maxillary sinus and 5% for ethmoid sinus which was confirmed by endoscopy of sinus surgery, the sensitivity of computed tomography 96% in diagnosis of sinusitis of and specificity 90%.

Conclusions: The sensitivity of plain film in the diagnosis of sinus disease, particularly of the ethmoidal and sphenoidal sinuses is low and shows limitation for use in directing endoscopic surgery, therefore should be replaced by coronal CT scan especially of the patients subjected as candidates for endoscopic sinus surgery to see middle meatal complex and this contents.

مقارنة أشعة الجيوب الأنفية مع أشعة المفراس المقطعي في تشخيص التهاب الجيوب الانفية

الخلاصة

الغرض: تقييم قيمة الأشعة العادية لاستنباه التهاب الجيوب الأنفية للمرضى مقارنة مع أشعة المفراس .

المرضى وطرائق البحث: أجريت دراسة مقطعية ل ١٠٠ مريض يشتبه بإصابتهم بالتهاب الجيوب الانفية بين تشرين الأول ٢٠٠٧ - كانون الثاني ٢٠٠٩ أعمارهم بين ٥ - ٣٠ سنة وتم إجراء فحص الأشعة العادية والمفراس للمرضى المصابين بالتهاب الجيوب الأنفية الحاد وتم استخلاص نسبة الحساسية والتخصصية لكل منهما كل مريض .

النتائج: خلاصة فحص الأشعة العادية ٣٣% لكن التحسسية كان ٤٥% ماعدا التهاب الجيوب الأنفية الوجهية ٨٠% لهذا فان فحص الأشعة العادية لالتهاب الجيوب الأنفية الوجهية أكثر منحا . القيمة التنبؤية السالبة بينما كانت حساسية الأشعة المقطعية للمفراس ٩٦% في تشخيص التهاب الجيوب الأنفية الحاد والتشخيصية ٩٠%

الاستنتاج:

١- حساسية الأشعة العادية في تشخيص عتمة الجيوب الأنفية في الحالة الحادة قليلة القبول للالتهاب الجيب الأنفي العيني والدماغي لكن التخصصية عالية

٢- إن لأشعة المفراس المقطعية تعطي ٩٦% صحة خصوصا في إجراء عمليات نازول الجيوب الأنفية الوظيفي.

Introduction

There are generally two commonly performed radiographic studies of the Paranasal sinuses, plain films and computed tomography. Customarily, plain films include the Waters', Caldwell's and lateral views of the sinuses[1]. They are useful in evaluating the transparency, size and integrity of these structures, but are limited in their evaluation of the sphenoids and ethmoids due to overlapping structures. In general, bony structures are seen with far more details than soft tissue. Computed tomography has largely replaced plain films, as it simultaneously displays bone, soft tissue and air, and their evaluations of the sinuses are in much greater detail and at an increasingly competitive cost [2,3].

The Submentovertical (water s) view is a posteroanterior projection performed with the patient's nose and chin on the film. This view is useful for evaluating the maxillary sinuses[4] The Caldwell view is taken with the nose and forehead on the film, and is useful in the evaluation of the frontal and ethmoid sinuses. The lateral view is most useful for evaluating the sphenoid and frontal sinuses[5]. The Submentovertical view can evaluate the sphenoid and ethmoid sinuses and abnormalities of foramen of skull base [4,5].

Viral sinusitis is classically seen as slight mucoperiosteal thickening. Bacterial sinusitis in general usually has an air fluid level, with one sinus affected greater than the others. In allergic rhinitis, bilateral mucoperiosteal thickening is seen, thus helping more or less in differentiating it from bacterial sinusitis[6].

Computed Tomography Since CT can simultaneously display bone and soft tissue and has the additional property of displaying selected anatomical areas

especially osteometal complex, especially for surgeons doing functional endoscopic sinus surgery, so it has largely replaced plain films x-ray[7].

Two series of views of CT are obtained, the coronal and the axial. The coronal cuts are much more useful as the osteomeatal complex is more clearly seen (to see patency of maxillary os, sphenoid sinus and any abnormalities ,polyps ,mucosal oedema ,etc). In some instances, the coronal cuts are adequate for diagnosis, while the axial views must be obtained if one contemplates surgery upon the sinuses (to see extent of the pathology and its complication) [7,8]

Patients and Methods

Between October 2007 and January 2009, 100 patients out of 200 patients who showed signs and/or symptoms of sinusitis (Table 1), those whose response to classical treatment was temporary or not satisfactory selected .

The patients had a history of flu with purulent nasal discharge or headache to site of involving sinus radiating to the forehead or postnasal drip or nasal obstruction or hyposmia and/or fever or frequent cough, referred by the managing ENT surgeons who suspected of sinusitis on clinical ground to the Radiological Department in Hilla Teaching General Hospital , for plain x-ray and computed tomography examination .

One hundred patients, ranging in age from 5 to 30 years (Table 2), including 60 male and 40 female Table (3)

100 consecutive patients were examined. Each patient underwent conventional X-ray and standard dose CT examinations during the same . The sensitivity and specificity of the plain film examination were evaluated (Table 4) sensitivity and specificity of each sinus by plain x-ray and

computed tomography were evaluated (Table 5) . The finding of patients by plain x-ray (opacification or air fluid level of one or more sinuses or negative x-ray finding) and finding by computed tomography were considered Table (7).

the patients in the study had conventional sinus radiographs consisting of either water view (occipitomental)Caldwell, Submentovertical, and lateral projections. The Patients who could cooperate, mainly those 6 years old or older, received a submentovertical projection, the x-rays are limited to a single occipitomenta (OM) view which considered adequate for basic assessment of the maxillary antra ,the frontal sinuses and the sphenoid sinus but is poor at excluding pathology of the ethmoid air cells or providening fine bony details.

The coronal CT scans were performed on the Siemens Somatom plus 4 and were 4-mm-thick sliced with 3- mm increments.

The gantry angulation varied depending on cranial hyperextension. The kilovoltage setting was 125, and the scanning time was 3-4 sec. The window width was 2000, with a center of zero. The images were zoomed to fill the screen. Sagittal reconstructions through the ethmoidal sinuses were performed with magnification that made the scans anatomically correct in size. This permitted direct measurements on the scan from the inferior anterior nasal spine to the cribriform plate or sphenoidal sinus, could be used to judge the depth of the sinus during endoscopic surgery.

The plain radiographs were interpreted prospectively and compared with the coronal CT scans . The CT scans were interpreted independently of the plain radiographs. The ethmoidal air cells were divided into anterior, middle, and posterior,

although the middle cells are part of the anterior system. The amount of mucous membrane thickening, opacification, air-fluid levels, location of disease, and bone destruction or expansion were recorded especially the lamina papyracea (ie: medial wall of the orbit).

The appearance of the mucosa in the nasal cavity was assessed. Interpretations of the sinus radiographs and CT scans were compared, and any discrepancies noted. .

The endoscopy of sinuses surgery was considered the gold standard-that is, in the case of discrepancies between the CT scan and plain x-ray, endoscopy was considered to solve the problem .

Result

One hundred patients presented in Hilla Teaching Hospital of having different presentation of sinusitis. Table 1 shows clinical presentation of each patient, then plain film examination was done for all of them ,by plain film examination found the patients to have opacification or air fluid level of one or more sinus or negative plain x-ray but the patients with negative plain x-ray have clinical suspicion of sinusitis , then underwent CT examination in department of Radiology in Hilla teaching hospital follow by endoscopy of nasal sinus in Department of ENT in the same hospital during the period from October 2007 to January 2009 . All patients underwent endoscopy of nasal sinus and compare plain x-ray findings with computed tomography findings .

Of the 100 patients studied (ages listed in Table 2), findings over 90% of the CT scans were abnormal (Table 6) In about 80% of the patients, the findings on plain radiographs did not correlate with those on CT scans.

About 30% of the patients had normal findings on plain radiographs

of at least one sinus with an abnormality of that sinus shown on CT scans. Almost 30% of the patients had what was interpreted as an abnormality of at least one sinus on plain radiographs, but that sinus was normal on CT scans.

90 (90%) had an abnormality of a sinus shown on coronal CT scans table (6). In 80 (80%) of the 100 patients, discrepancies were seen between the interpretations of plain radiographs and those of CT scans. Thirty patients (30%) had normal plain radiographic findings of a sinus but had abnormal findings on CT of that sinus.

The findings are summarized in (Table 7). Themes were more discordant interpretations of the ethmoidal sinuses than of any other sinuses. The abnormalities noted only on CT included partial ethmoidal clouding, small sphenoidal or frontal sinuses with soft-tissue disease, and posterior on medially placed mucous membrane thickening or retention cysts of the maxillary sinuses.

Some maxillary sinuses that appeared opacified on plain radiographs were shown to be retention cyst on coronal CT.

On CT scans, no bone destruction was noted. Only 30% of 100 patients had no sphenoidal sinus development on CT. The youngest patient with sphenoidal sinus development was 5 years old [2]. All but three of the thirty patients thought to have sphenoidal sinus clouding by plain radiographic findings, but with normal findings on CT scans, were less than 10 years old. No cases of isolated sphenoidal sinus disease were seen. Fifteen sphenoidal sinuses had soft-tissue disease shown on CT scans. The lateral film was useful in evaluating the size of the adenoids, but was of no value in patients less than 5 years old and tended to overestimate sphenoidal

clouding in patients between 5 and 10 years old. The submentovertex radiograph was added on patients 6 years old and

older and was of value in only one patient with a hypoplastic maxillary sinus.

In the evaluation of ethmoidal sinuses and maxillary sinuses by CT, it was found that of the 200 ethmoidal and 200 maxillary sinuses of 100 patients.

190 (95%) ethmoidal sinus had ethmoidal sinus abnormalities on CT, whereas maxillary sinuses were abnormal in 196 (98%) maxillary sinus.

4 (2%) of the 190 abnormal ethmoidal sinuses had normal maxillary sinuses, and 10 (5%) of 196 abnormal maxillary sinuses had normal ethmoidal sinuses.

Soft-tissue disease, mucous membrane thickening, and secretions in the nasal cavity noted on coronal CT scans were poorly shown on plain radiographs.

Ethmoidal sinus involvement was not accurately localized on plain radiographs, but was shown on CT scans (Fig. 6). Sagittal reconstructions through the ethmoidal sinuses were useful for measuring distances between the inferior nasal spine and the top of the ethmoidal air cells or distance to the sphenoidal sinuses on to help localize ethmoidal disease (Figs. 6). Plain radiographs were not useful for detecting prior endoscopic surgery (Fig. 7).

Although all Paranasal sinus radiographs and coronal CT scans were reviewed by one of the authors, the original interpretations were used for the study. There was little discrepancy with the interpretations of the CT scans. Some variation existed in the interpretations of Paranasal sinus

radiographs, but the overall results were not appreciably altered.

Table 1 Symptomatology of 100 patients complain sinusitis

Symptom of patient	No. of patient
Purulent nasal discharge	20
Headache	٣٠
Postnasal drip	١٦
Nasal obstruction	١٢
Hyposmia	١٠
fever	٦
Frequent cough	٦
Total	١٠٠

Table 2 Distribution of sinusitis in relation to age of patients

Age	Number
5-9years	10
10-14 years	15
15-19 years	20
20-24 years	32
25-30 years	23
total	100

Table 3 Distribution of patients in relation to sex

Sex	number
Male	60
Female	40

Table 4 Validity of plain x-ray in diagnosis of sinusitis

	sinusitis	No sinusitis	Total
Plain x-ray positive	TP 25	FP 30	55
Plain x-ray negative Computed tomography +ve	FN 30	TN 15	45
Total	55	45	100

Sensitivity : $TP/TP+FN = 25/55 = 45\%$

Specificity : $TN/TN+FP = 15/45 = 33\%$

Positive predictive value $TP/FP+TP = 25/55 = 45\%$

Negative predictive value : $TN/TN+FN = 15/45 = 33\%$

- TP:true positive

- TN:true negative
- FP:false positive
- FN:false negative

Table 5 Sensitivity and specificity of each sinus by plain x-ray and computed tomography

sinus	Plain x-ray		computed tomography	
	sensitivity	specificity	sensitivity	specificity
Maxillary sinus	80%	70%	98%	95%
Ethmoids sinus	35%	50%	95%	89%
Frontals sinu	41%	47%	93%	86%
Sphenoidal sinus	26%	40%	100%	93%

Table 6: Results of Plain Radiography and CT of Paranasal Sinuses

	Ethmoidal	Maxillary	Sphenoidal
Frontal			
No. of sinuses evaluated	200	200	70
140			
No. of abnormal sinus by	82	160	22
50			
plain x-ray			
No. of patients with abnormal	190	196	70
130			
sinuses on CT scans ($n = 100$)			

Table 7 Finding of each sinus by computed tomography

	Ethmoidal	Maxillary	Sphenoidal	Frontal
Mucosal thickening	100	80	55	50
Fluid level	3	40	2	56
Retention cyst	0	30	1	10
polyp	90	40	0	0
mucocoele	0	30	0	8
Bone thinning				
Expansion	10	11	6	12
destruction	0	0	0	0
Osteometal complex				
Patent	20	15	6	10

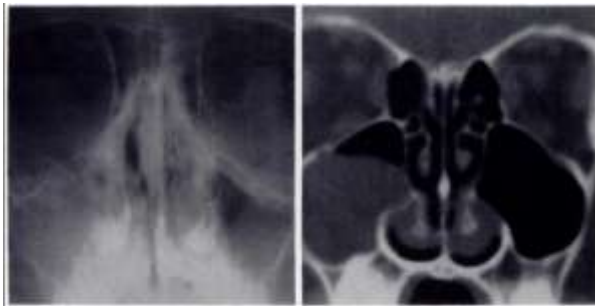


Figure1 Waters projection radiograph of a 9-year-old Interpreted as complete opacification of maxillary sinus. Coronal CT scan shows a large retention cyst.



Figure 2 Caldwell projection radiographs of a 6-year-old that seem to show ethmoidal disease. Representative CT scans show no evidence of ethmoidal

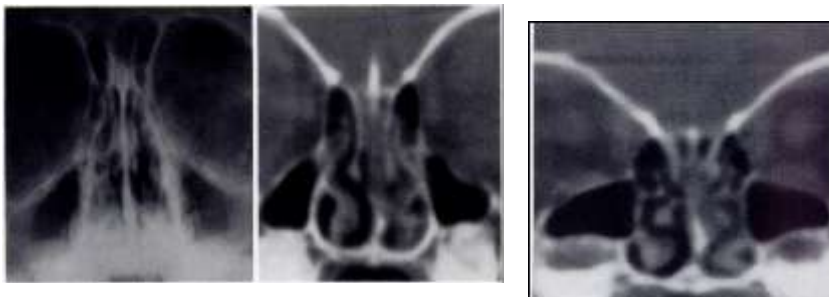


Figure 3 Waters projection radiograph of a 12-year-old boy interpreted as partial opacification of right maxillary sinus. Coronal CT scan is normal

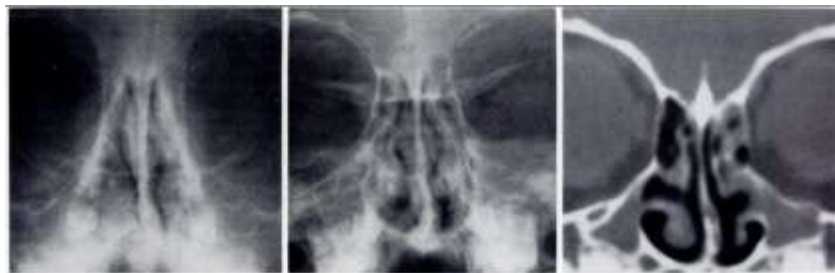


Figure 4 Waters and Caldwell projection radiographs of 5-year-old boy show opacified maxillary sinuses and ethmoidal clouding. Anterior coronal CT scan shows opacified maxillary sinuses and clouding of left ethmoidal air cells.

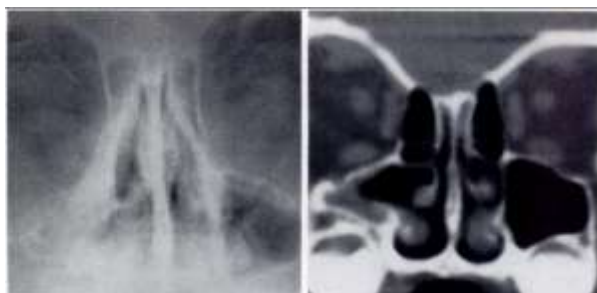


Figure 5 Waters view radiograph of a 7-year-old, obtained after endoscopic surgery, was interpreted as complete opacification of right maxillary sinus. Coronal CT scan shows removal of uncinate process and a wide opening of that sinus into nasal cavity. Note moderate mucous membrane thickening.

Discussion

Our prospective study compared sinus radiographs with coronal CT scans. The assumption was made that coronal CT scans accurately depict sinus anatomy and disease[7].

Finding in this study sensitivity of plain x-ray in diagnosis sinusitis is low except for maxillary sinus 80% this finding consist with finding of Aalokken [8] whose finding sensitivity of plain x-ray is low except for maxillary sinus .

While sensitivity of the Para nasal sinus computed tomography in diagnosis of sinusitis is high this finding consist with finding of Bhattacharyya [9]whose finding high sensitivity of Para nasal CT in diagnosis of chronic sinusitis .

In our study we found plain film radiographs are compared with the CT scans, a 75-80% disagreement occurs. This means that plain film radiography reveals disease in 30% of cases in which no disease is demonstrated on CT scanning and that plain film radiographs appear normal in 35-40% of cases in which disease is found on CT scanning; this is the same finding by Girish [10]

The plain radiographs both underestimated and overestimated sinus disease. Ethmoidal, sphenoidal, and maxillary sinus mucous membrane thickening on opacification noted on plain radiographs was not documented on CT scans. The appearance of partial ethmoidal clouding can occur on the Caidwell projection ,possibly caused by superimposed ethmoidal air cells, nasal secretions, mucous membrane thickening, and variations in plain radiographic techniques[11,12].

The sloping lateral and superior maxillary sinus walls can be interpreted as mild mucous membrane thickening. The angulation required to image maxillary sinuses can result in

double contours, simulating maxillary sinus disease[13]. A hypoplastic maxillary or a small frontal sinus can appear to be diseased. Anterior ethmoidal air cells in the Waters projections often appeared cloudy, but frequently appeared normal on CT scans. Small normal sphenoidal air cells can appear partially opacified on lateral sinus radiographs.

Partial ethmoidal disease noted on CT scans may not be shown on conventional radiographs. This is not unexpected when plain radiographs and CT scans are compared elsewhere in the body. The agreement between plain radiographs and CT scans was best in the maxillary sinuses, although minimal to modest mucous membrane thickening, especially posteriorly, or posterior retention cysts may not be evident on plain radiographs. Some clinicians request only a Waters projection when evaluating a patient for sinusitis[14,15].

In our study, 23% of the patients with normal maxillary sinuses had ethmoidal sinuses that were abnormal on CT scans, thus casting doubt on the value of a Waters projection in excluding sinus disease. In 25% of the patients with maxillary sinus clouding on Waters projections confirmed by CT, the ethmoidal sinuses were normal.

Lateral sinus radiographs in children of less than 6 years old were found to be of little value, and we have dropped this projection from our plain film routine. Submentovertex projections contributed little diagnostic information in this group of patients [16,17]

This study did not address the controversial issue of the significance of soft-tissue sinus disease seen on CT scanning done for reasons other than clinical sinus disease. Although the exact number of discrepancies between plain radiographs and coronal CT

scans would be different had another group of radiologists performed the interpretations.

Conclusions

From This study we conclude :

1- plain film not neglect the value of plain radiographs in the evaluation of sinus disease, especially in the presence of clinical feature acute sinusitis,

2- Plain film shows limitations of paranasal sinus radiographs in the diagnosis of sinus disease, particularly of the ethmoidal and sphenoidal sinuses and of their use in directing endoscopic surgery.

3- Therefore it should be replaced by coronal CT scan especially of the patients subjected as candidates for endoscopic sinus surgery to see middle meatal complex & these contents.

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