

Issue Year : 2011, **Issue Number :** 3, **Issue Month :** September

Written By : Ruqqayia Adil, Abdul Qayyum, Adil Qayyum

Belongs To : Combined Military Hospital Rawalpindi

CORRELATION OF X RAYS AND COMPUTED TOMOGRAPHY IN PARANASAL SINUS DISEASES

Abstract

Objective: Objective of the study was to evaluate the diagnostic yield of X-rays taking CT scan as gold standard in acute and chronic sinusitis. **Study Design:** Validation study.

Place and Duration of study: The study was conducted in the Radiology Department CMH Rawalpindi, from 1st Aug 2007 to 31st July 2008.

Patients and Methods: This study involved 95 patients of both genders above 18 years of age who presented with acute and chronic sinusitis in ENT department of CMH Rawalpindi. Patients were referred to Radiology department for their X-ray paranasal sinuses (PNS) and findings were correlated with CT scan.

Results: Out of 43 patients clinically suspected of having acute sinusitis, x ray PNS shows imaging findings of acute sinusitis in 26 (60%) patients while 17 patients were having normal x-ray PNS. When CT scan was performed to correlate the findings, it showed 30 (69%) patients were having acute sinusitis while 13 (30%) patients had no imaging findings of sinusitis. Out of 48 patients, x ray PNS showed chronic sinusitis in 26 (54%) patients and 22 patients were having normal x ray PNS. While CT scan showed 33 (68%) patients were having chronic sinusitis and 15 patients were normal. Four patients either didn't reported for their CT scan or they refused to get their CT scan done.

Conclusion: Plain radiographs were once the mainstay of diagnosis of sinus disease and now have been replaced by high-resolution CT scan for the evaluation of acute and chronic sinusitis. Plain radiographs do not allow adequate evaluation of the osteomeatal complex or of the sphenoid and ethmoid sinuses because of overlapping anatomic structures. CT is the modality of choice for imaging acute and chronic sinusitis and provides the surgeon with important information of the osteomeatal complex and normal variations, preoperatively.

Article

INTRODUCTION

Imaging of paranasal sinuses plays an important role in diagnosing paranasal sinus diseases. The most common diseases to affect the paranasal sinuses are inflammatory¹, and the last several years have seen a revolution in our understanding of inflammatory disease of the paranasal sinuses. The advent of functional endoscopic sinus surgery, to replace the more traditional Caldwell-Luc procedure as the treatment of choice of chronic sinusitis, has placed new demands on imaging of the paranasal sinuses. Present day paranasal sinus imaging allows for earlier diagnosis, better tumour mapping, and accurate treatment planning, all of which may contribute significantly to influence the patient's treatment and ultimate longevity.

Plain radiographs do not allow adequate evaluation of the osteomeatal complex. Other important limitations of plain radiographs include difficulty in differentiating between infection, tumour² and polyp in an opacified sinus³. Plain radiographs of even the highest quality will underestimate the presence and extent of soft tissue disease and bone erosion. CT scans can provide much more detailed information about the anatomy and abnormalities of the paranasal sinuses than plain films⁴ especially pathologies within the sphenoid and ethmoid sinuses^{5,6}. Close clinical correlation helps determine when a normal plain film study actually constitutes an adequate radiologic evaluation. Nonetheless, these plain film studies may still be the first x-ray examination obtained, and analysis of these films may determine whether more sophisticated studies are required.

Plain radiography has a limited role in the management of sinusitis. Possible findings in acute sinusitis include mucosal thickening, air-fluid levels, and partial or complete opacification of the involved sinus^{7,8}. Although mucosal thickening is seen in more than 90 percent of sinusitis cases, it is a nonspecific finding^{9,10}. Air-fluid levels and complete opacification are more specific for sinusitis but are seen in only 60 percent of sinusitis cases⁹. Interpretation of plain radiographs can vary widely among different observers and there is a high rate of false negative results^{3,11}.

High resolution CT scan provides excellent bone detail and accurate soft tissue mapping¹². CT is the modality of choice for imaging inflammatory disease of the sinuses and the osteomeatal complex. High resolution CT is used routinely before functional endoscopic sinus surgery^{13,14} to evaluate the extent of the inflammatory disease and to assess important anatomic landmarks and their variations. The extent of surgery is dictated by the extent of disease as determined preoperatively by the CT scan. CT scans can provide much more detailed information about the anatomy and abnormalities of the paranasal sinuses than plain films¹³. The primary role of CT scans is to aid in the diagnosis and management of recurrent and chronic sinusitis, or to define the anatomy of the sinuses prior to surgery¹⁵.

Coronal CT image is the preferred initial procedure. Bone window views provide excellent resolution and a good definition of the complete osteomeatal complex and other anatomic details. Axial 5-mm CT scans should be obtained supplemented by coronal sections for lesions involving the roof of the maxillary antrum and hard palate and for the detection of orbital and cranial invasion¹⁶. The complete examination of the paranasal sinuses and nasal fossae is obtained by a combination of axial and coronal studies¹⁷. Enhancement by intravenous contrast medium is of value for the characterisation of soft tissue masses, in order to determine the presence of cyst formation or necrosis and for the differentiation of solid or fluid sinus contents.

Objective of this study was to evaluate the diagnostic yield of X-rays taking CT scan as gold standard in acute and chronic sinusitis.

MATERIALS AND METHODS

This validation study was conducted in the Radiology Department CMH Rawalpindi, from 1st Aug 2007 to 31st July 2008. Ninety five patients of both gender above 18 years of age who presented with acute and chronic sinusitis in ENT department of CMH Rawalpindi were referred to Radiology department for their X-ray paranasal sinuses and findings were compared with CT scan. Four patients either did not reported for their CT scanner they refused for CT scan. Therefore finally 91 patients were included.

X ray paranasal sinuses were performed by Toshiba X-ray machine, 1000 mA. In all the patients, open mouth Water's view was performed in routine with chin elevated and in occipitomeatal plane, while the chin and nose were in contact with the x-ray film. If there was abnormality in ethmoid sinuses then Caldwell view was performed by using an occipitofrontal beam while the nose and forehead were in contact with the film. If there was abnormality in sphenoid sinuses on open mouth Water's view, then lateral view was performed for their further evaluation.

All CT scans were obtained with Toshiba Asteon 4 slice spiral CT scanner. After obtaining the scout projection, the area of scanning was defined to include the region from roof of frontal sinus upto the hard palate. Axial sections were performed with the patient in supine position and the plane of data acquisition parallel to hard palate. The sections were taken with slice thickness of 5 mm and table feed of 7 mm i.e. pitch of 1.4 . Images were reconstructed at 4 mm intervals i.e. image overlap of 1 mm. Scanning parameters included 105 mA, 130 kV and tube rotation time of 1.5 seconds. Coronal sections were performed with the patients in prone position with extended neck and the plane perpendicular to axial plane. The scan parameters were same as in axial plane. Extended cephalic / caudal sections were done in a few patients to see extension of the disease process.

The plain film findings of acute sinusitis include mucosal thickening, an air-fluid level and partial or total sinus opacification of paranasal sinuses. CT scanning is required when complications are suspected, or in the preoperative evaluation of surgical candidates. CT scans may show mucosal thickening, sinus opacification or reactive thickened sclerotic sinus walls. Coronal CT imaging was the preferred initial procedure. Bone-window views provide excellent resolution and a good definition of the complete osteomeatal complex and other anatomic details that play a role in sinusitis.

Statistical Analysis

Data was analyzed using SPSS version 10 and descriptive statistics were used to describe the data. Sensitivity, specificity, positive & negative predictive values and accuracy of x-ray paranasal sinuses were calculated taking CT scan as gold standard for acute and chronic sinusitis separately.

RESULTS

A total of 95 patients were included in the study. Four patients either did not report for their CT scan or they refused to get their CT scan done. Therefore these four patients were excluded in the study. Patients were 54 (59%) were males and 37 (41%) females, with a mean age of 45 years (range, 20–60 years).

Out of 43 patients clinically suspected of having acute sinusitis, x-ray PNS showed imaging findings of acute sinusitis in 26(60%) patients while 17 (40%) patients were having normal x-ray PNS. When CT scan was performed to validate the findings, it showed 30 (69%) patients were having acute sinusitis while 13 (30%) patients had no imaging findings of sinusitis (Table-1).

Table 1: Statistical evaluation of imaging findings of acute sinusitis in x-ray & CT PNS (n=43)

Imaging findings of Acute Sinusitis in CT PNS				
X-RAY PNS		Present	Absent	Total
	Present	True Positive 24	False Positive 2	26
	Absent	False Negative 6	True Negative 11	17
		30	13	43

X-ray PNS wrongly diagnosed 8 patients; 2 false positive and 6 false negative diagnosis. X ray PNS was 80% sensitive, 85% specific and 81% accurate for diagnosing acute sinusitis than CT scan. However most of the cases were diagnosed and managed clinically without any need for CT scan.

Out of 48 patients clinically suspected of having chronic sinusitis, x-ray PNS showed imaging findings of chronic sinusitis in 26(54%) patients while 22 (46%) patients were having normal x-ray PNS. When CT scan was performed, it showed 33 (68%) patients were having chronic sinusitis while 15 (31%) patients had no imaging findings of sinusitis (Table 2).

Table 2: Statistical evaluation of imaging findings of chronic sinusitis in x ray & CT PNS (n=48)

Imaging findings of Chronic Sinusitis in CT PNS				
X-RAY PNS		Present	Absent	Total
	Present	True Positive 19	False Positive 7	26
	Absent	False Negative 14	True Negative 8	22
		33	15	48

X ray PNS wrongly diagnosed 21 patients; 7 false positive and 14 false negative diagnosis. X-ray PNS had low sensitivity (58%), specificity (53%) and accuracy (56%) for diagnosing chronic sinusitis because of the inadequate evaluation of the sphenoid and ethmoid sinuses and their overlapping anatomic structures (Table 3).

Table 3: Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of x ray paranasal sinuses for diagnosing paranasal sinus diseases.

Acute Sinusitis	80	85	92	65	81
Chronic sinusitis	58	53	73	36	56

Most of false positive and false negative results were due to wrong diagnosis of chronic ethmoid and sphenoid sinusitis which were picked up and diagnosed on CT scan.

DISCUSSION

Most common diseases to affect the paranasal sinuses are inflammatory diseases¹. The advent of functional endoscopic sinus surgery as the treatment of choice of chronic sinusitis has placed new demands on imaging of the paranasal sinuses. Present day paranasal sinus imaging allows for earlier diagnosis, better tumour mapping, and accurate treatment planning, all of which may contribute significantly to influence the patient's treatment and ultimate longevity.

Acute sinusitis is a bacterial or viral infection of the sinuses of fewer than 4 weeks duration that resolves completely with appropriate treatment. Subacute sinusitis represents a temporal progression of symptoms for 4-12 weeks. Recurrent acute sinusitis is diagnosed when 2-4 episodes of infection occur per year with at least 8 weeks between episodes and the sinus mucosa completely normalizes between attacks¹⁸. In our study the plain film findings of acute sinusitis included mucosal thickening, air-fluid level and partial or total sinus opacification of paranasal sinuses. Mucosal thickening was seen as a soft-tissue layer of mucosa separating the sinus bony wall from the sinus air cavity. In the antrum, this was best detected along the lateral antral wall in the Waters view. These findings are in consistent with international studies by Varonen et al¹⁹.

Interpretation of plain radiographs can vary widely among different observers and there is a high rate of false negative results^{3,11}. Plain films cannot distinguish between acutely inflamed and chronically scarred mucosa. However contrast enhanced CT showed mucosal enhancement in active inflammation. CT scanning was required when complications were suspected, or in the preoperative evaluation of surgical candidates. Limitations of plain films include interobserver variability, inability to distinguish infection from a polyp or tumor disease, and poor depiction of the ethmoid and sphenoid sinuses. However, in the ethmoid sinuses, the most common manifestation of infection in our study was blurring of the intracellular septa or a mild haziness, rather than discrete mucosal thickening.

On plain films, the sphenoid sinus is often described as appearing normal in the presence of antral disease; however, bacteriologic studies have shown that in 67-75% of these patients, the same infection is present in the sphenoid sinus. It has been estimated that nearly 50% of the cases of sphenoid sinusitis go undetected on plain film examination²⁰. However, CT will consistently detect these cases. In our study x-ray PNS shows 80% sensitivity, 85% specificity and 81% accuracy for diagnosing acute sinusitis which is in comparison with international studies by Thomas et al²¹. However most of the cases were diagnosed and managed clinically without any need for CT scan.

Chronic sinusitis is an inflammatory process that involves the paranasal sinuses and persists for 12 weeks or longer. In our study we observed that plain x-ray films do not have a role in diagnosing chronic rhinosinusitis. Plain radiographs do not allow adequate evaluation of the osteomeatal complex or of the sphenoid and ethmoid sinuses, because of overlapping structures. Plain radiographs of even the highest quality will underestimate the presence and extent of soft tissue disease and bone erosion. These findings are in consistent with international studies by Brook et al²².

High resolution CT scan provides excellent bone detail and accurate soft tissue mapping¹². Our study showed that CT is the modality of choice for imaging inflammatory disease of the sinuses and the osteomeatal complex. CT scans showed mucosal thickening, sinus opacification and reactive thickened sclerotic sinus walls. These findings are consistent with international studies by Rosenfeld et al²³. In our study x-ray PNS shows 58% sensitivity, 53% specificity and 56% accuracy for diagnosing chronic sinusitis which is in favorable comparison with international studies by Stewart et al²⁴. Most of false positive and false negative results were due to wrong diagnosis of chronic ethmoid and sphenoid sinusitis which were picked up and diagnosed on CT scan.

Our study has certain important clinical implications. A common approach towards the patients suspected of having sinus inflammatory diseases is to advise x ray PNS. However plain radiographs do not allow adequate evaluation of the osteomeatal complex or of the sphenoid and ethmoid sinuses and many of the findings and diagnosis are missed by radiography. Therefore whenever there is high index of suspicion of chronic sinus inflammatory diseases like chronic sinusitis, fungal sinusitis, polyps or mucocoele, CT scan should be advised as it is the modality of choice for further evaluation of disease. Acute sinusitis is a clinical diagnosis and mostly imaging is not required, but when complications are suspected then CT PNS should be advised for further evaluation.

There were few limitations in our study. Firstly, the sample size was small consisting of 91 patients. It could not be increased, as CT is an expensive investigation and the study would not have remained cost effective. Secondly, with non-probability purposive sampling which was done on a predetermined idea of selecting patients with suspicion of acute and chronic sinusitis, the results of our study could not be generalized giving a low negative predictive value of imaging. Thirdly, as only one reviewer was used, no assessment regarding interobserver reliability is available.

CONCLUSION

We conclude that plain radiographs were once the mainstay of diagnosis of sinus disease but now have been replaced by high-resolution CT scan for the evaluation of sinus inflammatory diseases. Plain radiographs do not allow adequate evaluation of the osteomeatal complex or of the sphenoid and ethmoid sinuses because of overlapping anatomic structures. CT is the modality of choice for imaging inflammatory disease of the sinuses and the osteomeatal complex and provides the surgeon with important information of normal variations, preoperatively.

Reference

1. Skoulas IG, Helidonis E, Kountakis SE. Evaluation of sinusitis in the intensive care unit patient. *Otolaryngol Head Neck Surg* 2003;128(4):503-9.
2. Ahmad M, Khan MA, Cheema KM, Hameed A. Malignant tumors of nose and paranasal sinuses. *Ann KE Med Coll* 2000;6:169-70.
3. Poole MD. A focus on acute sinusitis in adults: changes in disease management. *Am J Med* 1999;106:38-47.
4. Jorissen M. Recent trends in the diagnosis and treatment of sinusitis. *Eur Radiol* 1996;6:170-6.
5. Low DE, Desrosiers M, McSherry J, Garber G, Williams JW Jr, Remy H, et al. A practical guide for the diagnosis and treatment of acute sinusitis. *CMAJ* 1997;156:1-14.
6. Nass RL, Holliday RA, Reede DL. Diagnosis of surgical sinusitis using nasal endoscopy and computerized tomography. *Laryngoscope* 1989;99:1158-60.
7. Bashir Ahmed, Amer Sabih Hydri, Shahid Farooq. Role of Plain Radiology in Chronic Maxillary Sinusitis. *Pak J Otolaryngol* 2003;19:8-11.
8. Ali NS. Evaluation and management of sinusitis in general practice. *J Pak Med Assoc* 1999;49:125-6
9. Willett LR, Carson JL, Williams JW Jr. Current diagnosis and management of sinusitis. *J Gen Intern Med* 1994;9:38-45.
10. Kuhn JP. Imaging of the paranasal sinuses: current status. *J Allergy Clin Immunol* 1986;77:6-8.
11. Skinner DW, Richards SH. A comparison between sinus radiographic findings and the macroscopic appearances of the para-nasal sinus mucosa. *Ear Nose Throat J* 1991;70:169-72.
12. Babbel R, Harnsberger HR, Nelson B. Optimization of techniques in screening CT of the sinuses. *Am J Neuroradiol* 1991;12:849-54.
13. Mian MY. Endoscopic sinus surgery (editorial). *Pak J Otolaryngol* 1999;15(1):1.
14. Ali MM, Awan MS, Mian MY. Nasal endoscopy: its importance in post operative care after functional endoscopic sinus surgery. *Pak J Otolaryngol* 1999;15(1):4-6.
15. Barzilai G, Greenberg E, Uri N: Indications for the Caldwell-Luc approach in the endoscopic era. *Otolaryngol Head Neck Surg* 2005;132(2): 219-20.
16. Tonai A, Bala S. Anatomic variations of the bone in sinonasal CT. *Acta Otolaryngol.* (Stockh) 1996;525:9-13.
17. Ray C E Jr, Mafee M F, Friedman M, Tahmoressi C N. Applications of three dimensional CT imaging in head and neck pathology. *Radiol Clin North Am* 1993;31:1-20.
18. Lanza DC, Kennedy DW. Adult rhinosinusitis defined. *Otolaryngol Head Neck Surg* 1997;117(3):1-7.
19. Varonen H, Rautakorpi UM, Nyberg S, Honkanen PO, Klaukka T, Palva E, et al. Implementing guidelines on acute maxillary sinusitis in general practice--a randomized controlled trial. *Fam Pract* 2007;24(2):201-6.
20. Grillone GA, Kasnica P: Isolated sphenoid sinus disease. *Otolaryngol Clin North Am* 2004;37(2):435-51.
21. Thomas F. Burke, Andrew T. Guertler, James H. Timmons. Comparison of Sinus X-rays with Computed Tomography Scans in Acute Sinusitis. *Academic Emergency Medicine* 1994;1(3): 235-9.
22. Brook I. Acute and chronic bacterial sinusitis. *Infect Dis Clin North Am* 2007;21(2):427-48.
23. Rosenfeld RM, Andes D, Bhattacharyya N, Cheung D, Eisenberg S, Ganiats TG, et al. Clinical practice guideline: adult sinusitis. *Otolaryngol Head Neck Surg* 2007;137(3):1-31.
24. Stewart MG, Johnson RF. Chronic sinusitis: symptoms versus CT scan findings. *Curr Opin Otolaryngol Head Neck Surg* 2004;12(1):27-9.