

Diagnostic Accuracy of CT Scan in Diagnosing Paranasal Fungal Infection

Junaid Iqbal, Sadia Rashid, Jaideep Darira, Muhammad Kashif Shazlee, Muhammad Saad Ahmed and Sumayya Fatima

ABSTRACT

Objective: To assess the diagnostic accuracy of CT scan in detecting paranasal sinus fungal infections.

Study Design: Cross-sectional, observational study.

Place and Duration of Study: Department of Radiology, Ziauddin University Hospital, Karachi, from April to September 2014.

Methodology: Patients with clinical suspicion of fungal sinusitis were included in this study. Patients with already diagnosed or history of recurrent fungal infections were excluded. All these patients underwent CT scan examination of paranasal sinuses. Findings were recorded. Final diagnosis was based on smear analysis for fungal culture. Accuracy analysis was conducted for CT diagnosis using smear analysis as the gold standard. Kappa analysis was conducted to determine agreement.

Results: Out of the 120 patients, 71 (59%) were male. The sensitivity, specificity, positive predictive value and negative predictive value of CT were 96.19%, 93.33%, 99.01%, 77.77%, respectively. The diagnostic accuracy was 95.83%. Kappa statistics showed 82% agreement beyond chance.

Conclusion: CT scan is highly accurate in diagnosing and characterizing fungal infection of paranasal sinuses. It also determines the extent of disease which eventually aids in deciding the surgical approach to be used.

Key Words: *Paranasal sinus fungal infection. Computed tomography. Radiological diagnosis.*

INTRODUCTION

Computed Tomography (CT) scanning is the imaging modality of choice in diagnosing many pathologies.¹⁻³ It is preferred over not only invasive techniques but also over conventional radiography as it provides superior resolution of bone and soft tissue and also removes superimposed overlapping structures. The introduction of spiral CT has opened new horizons to the radiographic imaging in single breath hold as it eliminates the breathing and misregistration artefacts.⁴ Furthermore, in real life settings, multi-slice CT scans are associated with lesser patient discomfort owing to shorter and fewer breath holds and minimizing need of sedation for restless patient.⁵

Early detection in case of fungal rhinosinusitis is necessary to optimal treatment and prevention of complications. In the extremely common manifestations of fever, headaches, stuffy nose and nasal discharge, especially in the presence of other comorbid conditions like Diabetes mellitus, it is extremely important to diagnose and treat fungal rhinosinusitis to prevent complications and manifestations like nasal crusting,

proptosis, bone destruction, and cranial nerve abnormalities. Fungal infections can mimic a whole range of bacterial pathology from acute to chronic granulomatous infections.⁶ Plain X-rays of the paranasal sinuses may show a non-specific opacification of the involved sinuses. In advanced cases erosion and destruction of the adjacent areas with soft tissue mass. Given the superiority of the spiral CT scanning is an excellent non-invasive diagnostic tool in whom fungal sinusitis is suspected.⁷

Plain radiographs of the sinuses are now considered of limited usefulness owing to large number of false results, while CT scanning is "the imaging modality of choice confirming the extent of pathology and the anatomy".^{9,10}

There are five basic types of fungal rhinosinusitis based on diagnostic categories of which three are invasive and two are non-invasive.¹¹ Allergic fungal sinusitis is associated with bone invasion with intracranial and intra-orbital extension. Since the disease is slow progressing and can be neglected by the patient for a long time, it can silently involve bony structure and might proceed to dural invasion, extensive cranial involvement and orbital involvement which might require craniotomy. Although sinusitis is common in Pakistani population, especially inhabitants of Karachi city with considerable pollution and humidity, the role of CT scan in the diagnosis of the condition has never been explored before which can provide a quicker yet reliable diagnostic alternative compared to histopathology. Therefore, the objective of this study was to assess the diagnostic accuracy of CT scan in detecting paranasal fungal infections.

Department of Radiology, Ziauddin University Hospital, Karachi.

Correspondence: Dr. Junaid Iqbal, Senior Registrar, Department of Radiology, Ziauddin University Hospital, Karachi.

E-mail: j.i.duhs@gmail.com

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METHODOLOGY

This study was conducted from April to September 2014 to assess the diagnostic accuracy of CT scan in detecting paranasal fungal infection taking culture as gold standard. One hundred and twenty patients, aged between 20 and 60 years, presenting at the Department of Radiology, Ziauddin University Hospital, Karachi undergoing CT scan for clinically suspected paranasal fungal infection, were enrolled for the study after informed consent. Patients with already diagnosed or history of recurrent fungal infections were excluded.

CT scan of paranasal sinuses was performed on Toshiba Asteion multislice CT scanner without contrast in the coronal and axial planes with the patient lying prone and supine. The scanning values were 3-mm section thickness; 5-second scan time, 3-mm reconstruction interval, 450 mAs and 125 kVp.

Images were analyzed by a senior radiologist having at least 5 years post-fellowship experience. Relevant patient data was collected on the proforma regarding their biodata, presenting complaints, provisional clinical diagnosis along with radiological findings.

Regardless of CT scan results suggestive of presence or absence of fungal disease, all patients in the study underwent culture which was taken as gold standard in the study. Culture results were then followed and recorded on proforma

Data was collected and analyzed using IBM SPSS (Chicago, IL) version 20. Male to female ratio for gender and mean \pm SD for age distribution was computed. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of Computed Tomography in detecting fungal infection of paranasal sinuses by taking culture analysis as the gold standard. Kappa statistic was calculated to take exclude agreement by chance between the two diagnostic techniques. P-value of ≤ 0.05 as statistically significant.

RESULTS

A total of 49 (41%) of 120 patients were female while remaining 71 (59%) were male. The mean age of the patients was 35.2 ± 11.61 years. Thirty-three (27.5%) were between age 20-30 years, 35 (29%) were between age 30-40 years, 29 (24%) were between 40-50 years, while remaining 23 (19%) were above 40 years. Bilateral fungal sinusitis was slightly more common; whereas, sphenoid and ethmoid sinuses were frequently involved. Table I shows the diagnostic accuracy including sensitivity, specificity, positive predictive value, negative predictive value and Kappa statistic.

Table I: Diagnostic accuracy of CT scan in diagnosing fungal sinusitis in 120 patients.

Condition*	Radiological Diagnosis	Sensitivity (95%CI)	Specificity (95%CI)	PPV (95%CI)	NPV (95%CI)	Validity (95%CI)	Kappa (p-value)
Paranasal fungal infection (n=105)	102	96.2 (90.6-98.5)	93.3 (70.1-98.8)	99.1 (93.8-99.9)	77.7 (51.9-92.6)	95.8 (92.2-99.4)	0.82 (<0.0001)

*As determined by culture; PPV = Positive predictive value; NPV = Negative predictive value.

Out of 105 patients with fungal sinusitis, 68 (64.76%) had bony invasions. Figures 1 and 2 show few of radiological findings including fungal sinusitis involving left maxillary sinus and sphenoid sinuses in the patients enrolled in the study.



Figure 1: Fungal sinusitis involving left maxillary sinus.

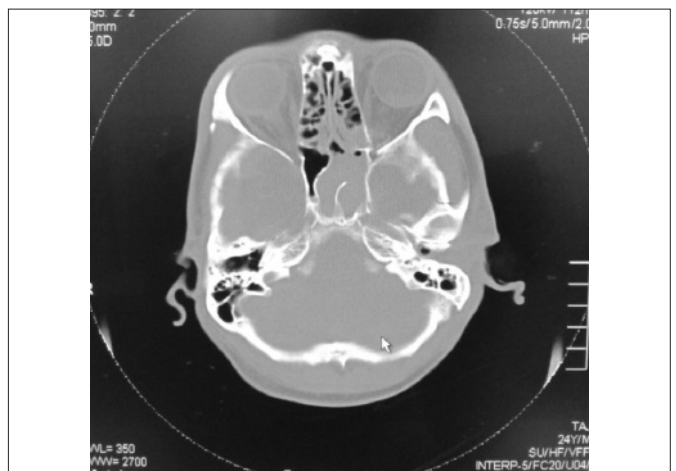


Figure 2: Fungal sinusitis involving sphenoid sinus.

DISCUSSION

During the past decade, fungal sinusitis has become a common disease in Pakistan.¹¹ Despite being at the uncommon end of sinusoidal diseases spectrum, it has been affecting the young and the immune-competent more frequently. The disease progresses slowly and often undiagnosed involving bony structure of the sinuses and the skull. Involvement of sinuses, bilaterally, has been seen much more commonly now pointing towards possible delay in diagnosis resulting in advanced disease. In such cases, bony involvement is

present requiring aggressive treatment interventions like craniotomy.¹² The gold standard diagnostic tool for the disease has been histopathology; and for long, X-rays have been employed to rule out any bone involvement. This might have played a role in underdiagnosis of the disease resulting in case presentations at fairly advance stages. The role of CT scan has not been investigated in our setting, which is far better than conventional X-ray.

This study reports superior diagnostic accuracy of CT scan for detecting fungal sinusitis in our setting. The Kappa statistic shows a very good agreement between CT scan results and culture results. In a country like Pakistan where there is an enormous burden on healthcare, additional dearth of histopathologists, and time needed for culture result support an accurate, non-invasive and quicker alternative for detecting fungal sinusitis. Properly performed and accurately interpreted CT imaging can significantly influence clinical management and is also cost-effective. Levels of sensitivity, specificity and accuracy were obtained similar to those achieved by other authors in this field, although an exact comparison is difficult because of the differences in patient selection.

In acute invasive fungal sinusitis, non-contrast CT demonstrate hypoattenuating mucosal thickening or an area of soft tissue attenuation within the lumen of the involved paranasal sinus and nasal cavity. Inflammation destroys the sinus walls aggressively, where thickening of the mucosa and erosion of the bone may not be very prominent. Paranasal sinuses may show collection of hyperattenuating soft tissue in non-contrast CT.¹³ Stammberger and associates found dense accumulation of phosphates and sulphates of calcium in sinus fungal masses of almost half of their patients.¹⁴

On unenhanced CT scan, they appear as hyperdense expansile mass with peripheral rim of hypodense mucosa, and may cause pressure erosion of the bones and rupture sinus walls. On post-contrast images, they are non-enhancing; and only peripheral mucosa may show enhancement. Invasive sinusitis spread rapidly through vascular invasion into orbits, CNS and cavernous sinus. Most common fungus isolated was *Aspergillus*, whereas *Penicillium* and *Rhizopus* were also isolated.

Other sinusitis appear hypodense and they are usually not involving CNS or orbit or bony structure or destruction.

According to literature, fungal sinusitis most commonly involves maxillary and ethmoid sinuses. Furthermore, unilateral involvement is more frequent. Fungal sinusitis rarely affects frontal sinus.^{15,16} However, in this study bilateral fungal sinusitis was slightly more common whereas sphenoid and ethmoid sinuses were frequently involved.

In another study¹⁷, 1,251 individuals screened for chronic sinusitis using CT scan, found fungal sinusitis in 25 people. Focal hyper-attenuation was present in 19 individuals. In this study, CT failed to identify fungal sinusitis in 3 individuals while 3 individuals were falsely labelled positive. The sensitivity was reported to be 76% in this study. The results of this study concur with the findings of researches conducted in other settings.¹⁸ On the basis of the results, an overall accuracy of 95.8% is an excellent measure supporting the role of CT in the diagnosis of paranasal sinusitis. Pakistan has a huge burden of immunocompromising diseases like diabetes mellitus.^{19,20} In this context, the rising incidences of such fungal infections also need quicker diagnosis.

CONCLUSION

Computed Tomography (CT) scan has superior and reliable diagnostic ability to detect paranasal fungal infections. The imaging modality can be used for rapid detection of such infections without waiting for the results of culture.

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