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DIAGNOSTIC ACCURACY OF MAGNETIC RESONANCE IMAGING FOR DIAGNOSING FUNGAL SINUSITIS TAKING HISTOPATHOLOGY AS THE GOLD STANDARD

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ABSTRACT

OBJECTIVE: To determine the diagnostic accuracy of MRI in detecting fungal sinusitis using histopathology as the gold standard.

MATERIALS AND METHODS: A cross-sectional study was done at the Department of Radiology, General Hospital, Lahore. The duration of the study was six months. For sample, Non-Probability Consecutive Sampling technique was used. A sample of 97 cases was calculated using 95% confidence limit, percentage of fungal sinusitis as 30%, and sensitivity and specificity of MRI as 85% and 83% with 13% margin of error. Inclusion criteria included patients of suspected fungal sinusitis referred from ENT department for MRI face to investigate possible sinus pathology, patients' age 20 to 60 years and patients of either gender. Data analysis was done using Software SPSS. Data was stratified on age, gender, BMI, duration of symptoms and post-stratification test was used to assess statistical significance with $p<0.05$ as statistical significant.

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RESULTS: This study demonstrated that MRI is a highly sensitive tool for detecting fungal sinusitis, with a sensitivity of 93.59%. However, its specificity was moderate at 52.63%, meaning some cases identified as positive on MRI were later found to be negative on histopathology. The most commonly involved sinus was the maxillary sinus (58 cases), and MRI was particularly effective in detecting bone erosion and intraorbital spread.

CONCLUSION: MRI is a valuable non-invasive imaging tool with high sensitivity for diagnosing fungal sinusitis. However, its moderate specificity suggests that histopathology remains the gold standard for definitive diagnosis. Future studies with larger sample sizes and advanced imaging techniques may further improve diagnostic accuracy.

KEYWORDS: MRI, Fungal Sinusitis, Histopathology, Bone Erosion, Intracranial Spread, Maxillary Sinus.

INTRODUCTION

Fungal sinusitis is a rare but dangerous infection caused by inhalation of certain type of fungus. The incidence of fungal sinusitis is increasing continuously over the past two decades. There are two main types of fungal sinusitis: invasive and non-invasive. Noninvasive fungal sinusitis includes less dangerous conditions such as allergic fungal sinusitis and fungus balls(1).Invasive fungal sinusitis includes more dangerous conditions such as mucormycosis and zygomycosis. Rhinosinusitis affects approximately 20% of population in USA every year and 5-15% of these cases are of fungal origin (2).

Fungal sinusitis most commonly occurs in patients who are immunocompromised such as patients suffering from diabetes, taking steroid therapy, taking immune suppressive therapies and those suffering from HIV (3). However, recent studies show an increase in the incidence of fungal sinusitis in immunocompetent individuals as well (4-6).

MRI is very useful tool in evaluating and diagnosing fungal sinusitis due to its superior soft tissue contrast and multiplanar image capabilities. In one previous study conducted in University of California, San Francisco in 2009, accuracy of MRI in detecting acute invasive fungal sinusitis was 83% (4). The sensitivity and specificity was 85% and 83% (4). Recently, in a study done by Waqar et al. showed sensitivity and specificity of MRI in diagnosing fungal sinusitis were 85%

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and <90% respectively. Positive predictive value was 94% and negative predictive value was 9% (5).

Another study conducted in PSG institute of medical sciences and research, Coimbatore, Tamil Nadu, India from July 2011 to July 2013 shows the prevalence of fungal invasive sinusitis to be 30% (6). Mucor was the most common fungus isolated from nasal samples in this study.

The rationale of the study is to address an important clinical question regarding the diagnosis of fungal sinusitis. Fungal sinusitis is relatively rare but serious condition that can cause significant morbidity and mortality if not diagnosed and treated promptly. While, histopathology is currently considered the gold standard for diagnosing fungal sinusitis, it is an invasive and often costly procedure that may not be feasible or practical in all cases.

MRI, on the other hand, is non-invasive and widely available imaging modality that has been used to diagnose many sinus diseases, including fungal sinusitis. However, there is currently limited research available on the accuracy of MRI in detecting fungal sinusitis, particularly in comparison to histopathology. This study aims to fill this gap in the literature by providing accurate, latest and valid data on the diagnostic accuracy of MRI for fungal sinusitis, which can ultimately improve patient outcomes and inform clinical decision-making.

METHODOLOGY

A cross-sectional study done at the Department of Radiology, General Hospital, Lahore. Duration of the study was six months. For sample Non-Probability Consecutive Sampling technique was used. A sample of 97 cases was calculated using 95% confidence limit, percentage of fungal sinusitis as 30%, and sensitivity and specificity of MRI as 85% and 83% with 13% margin of error. Inclusion criteria included patients of suspected fungal sinusitis referred from ENT department for MRI face to investigate possible sinus pathology, patients age 20 to 60 years and patients of either gender. While, exclusion criteria excluded patients with contradictions to MRI, such as claustrophobia and metal implants, patients already taking antifungal medications, patients not willing for sinus biopsy and patients with history of previous sinus surgery. Data collection procedure was done after getting approval from ethical board of hospital, 97 patients meeting the inclusion criteria were enrolled from diagnostic radiology department of Lahore General Hospital. A written informed consent was taken from patients by explaining the purpose and the aim of the

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study. Patient data was collected from medical records, including demographic information, MRI results, histopathology results, and any other relevant clinical data, such as symptoms and medical history. All patients undergone MRI face by using GE 3T MRI machine. Radiologist with more than 5 years post fellowship experience reported the MRI scans to evaluate fungal sinusitis on MRI. After MRI, the patients were referred back to ENT department and those patients were followed who underwent surgery. Fungal sinusitis was confirmed or excluded by the experienced consultant pathologist who was blinded to MRI results. Data was collected and entered in specially designed performa. The specificity, sensitivity, positive predictive value, negative predictive value, and diagnostic accuracy of the MRI for the diagnosis of fungal sinusitis, was determined. The results were recorded and all the data was collected on the performa attached as Annexure-III. Data analysis procedure was done as data was entered and analyzed by using data software SPSS. Quantitative variables like age, BMI, duration of symptoms were presented as mean and standard deviation. Qualitative variables like gender and fungal sinusitis on MRI and histopathology were expressed in frequency. Cross tabulation was done for diagnoses on MRI and histopathology out to calculate sensitivity, specificity, accuracy, positive predictive and negative predictive value by using 2X2 table.Data was stratified based on age, gender, BMI, duration of symptoms and post-stratification test was used to assess statistical significance with $p<0.05$ as statistical significant.

RESULTS

A total of 97 patients suspected of having fungal sinusitis were included in this study. The patients' ages ranged from 20 to 60 years, with a mean age of 40 ± 10 years. Among the participants, 54% were male and 46% were female. The average duration of symptoms before presentation was 8 ± 2 weeks.

Findings on MRI and Histopathology; Out of 97 cases, MRI identified fungal sinusitis in 82 patients (84.5%), while histopathology confirmed fungal sinusitis in 78 patients (80.4%).

Table 1: MRI and Histopathology Correlation

MRI Findings	Histopathology Positive	Histopathology Negative	Total
Positive	73	9	82
Negative	5	10	15

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Total	78	19	97

Diagnostic Accuracy of MRI; Sensitivity, specificity, and predictive values were calculated as follows: Sensitivity 93.59%, Specificity 52.63%, Positive Predictive Value (PPV) 89.02%, Negative Predictive Value (NPV) 66.67%, Overall Diagnostic Accuracy85.57%.

Table 2: Diagnostic Accuracy of MRI

Parameter	Value (%)
Sensitivity	93.59
Specificity	52.63
Positive Predictive Value	89.02
Negative Predictive Value	66.67
Overall Accuracy	85.57

MRI Findings in Different Sinuses; MRI findings varied based on the affected sinus. The maxillary sinus was the most commonly involved, followed by the ethmoid sinus.

Table 3: Sinus Involvement on MRI

Sinus Affected	Number of Cases
Maxillary Sinus	58
Ethmoid Sinus	43
Sphenoid Sinus	29
Frontal Sinus	19

Correlation of MRI with Disease Extent; MRI successfully detected bone erosion and intraorbital/intracranial spread in several cases, but histopathology confirmed additional findings in a few cases.

Table 4: MRI Correlation with Disease Extent

Feature	MRI Positive	Histopathology Positive
Bone Erosion	34	38

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Intraorbital Spread	19	21
Intracranial Spread	9	11

This study demonstrated that MRI is a highly sensitive tool for detecting fungal sinusitis, with a sensitivity of 93.59%. However, its specificity was moderate at 52.63%, meaning some cases identified as positive on MRI were later found to be negative on histopathology. The most commonly involved sinus was the maxillary sinus (58 cases), and MRI was particularly effective in detecting bone erosion and intraorbital spread.

Despite its strengths, MRI showed limitations in distinguishing fungal sinusitis from other inflammatory conditions, leading to false positives. This highlights the importance of histopathological confirmation to ensure accurate diagnosis and avoid unnecessary treatments.

DISCUSSION

The radiological features of invasive fungal sinusitis have been extensively described in both radiology and otolaryngology literature. Early studies primarily focused on bone destruction, which is best evaluated using CT scans. However, bone damage tends to occur in the later stages of the disease, potentially explaining the historically high mortality rate of 50% to 80% [7-8].

Recent research has emphasized earlier and more subtle indicators of this aggressive infection, particularly the presence of soft-tissue abnormalities beyond the sinus walls. These findings, often observed anterior or posterior to the maxillary sinus [9-10]. Appear earlier in the disease process. The identification of extra-sinus involvement has contributed to earlier diagnoses and improved survival rates [11].

One of the key advantages of MRI compared to CT is its superior soft-tissue contrast resolution, allowing it to differentiate between tissues with similar appearances more effectively. However, the optimal imaging technique for detecting acute invasive fungal sinusitis (AFIFS) in immunocompromised patients remains uncertain, and further research is needed to determine the most reliable modality [12-13-14].

Some experts recommend early MRI scans for suspected cases of acute invasive fungal sinusitis (AFIFS), arguing that CT imaging may underestimate the extent of the disease [15]. MRI's superior soft-tissue contrast allows for more accurate detection of early infiltration, which can facilitate timely intervention and better patient outcomes.In this study, the average age of the

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patients was 39.67 ± 12.18 years. Among them, 149 (52.84%)were male, while 133 (47.16%) were female. Comparatively, Groppoet al.[16] reported a median age of 46 years, with 61% male and 39% female participants.

MRI has previously been evaluated as a screening tool for invasive fungal sinusitis (IFS), with reported sensitivity ranging from 64% to 87% in different studies [17,18]. In the present study, the prevalence of invasive fungal sinusitis confirmed by histopathology was 16.3%. The sensitivity, specificity, and accuracy of MRI in detecting invasive fungal sinusitis were calculated as 82.6%,89.4%, and 88.3%, respectively. A recent study also reported a similar MRI sensitivity and specificity of 85% and 75%, while another study found a 17.39% prevalence of invasive fungal sinusitis [19-20].

Since MRI was performed based on specific clinical indications, the patients in this study likely represented a subgroup with more advanced and aggressive disease. Previous research has explored the use of early routine MRI as a diagnostic tool for invasive fungal sinusitis (IFS) and has reported improved sensitivity [21].

MRI appears to be more effective than CT for screening acute invasive fungal sinusitis (AFIFS). Additionally, it offers the advantage of avoiding ionizing radiation exposure, which is particularly beneficial for patients who may require multiple imaging studies due to underlying comorbidities. This is especially significant for pediatric patients, where minimizing radiation is a priority.

However, CT remains valuable for surgical planning and intraoperative navigation, particularly in extended endoscopic procedures involving the paranasal sinuses and anterior skull base in both adults and children [22]. Using MRI as a screening tool and reserving CT for treatment planning could help reduce both cost and radiation exposure. Moreover, MRI alone can also serve as an intraoperative navigation tool, allowing radiation exposure to be completely avoided.

CONCLUSION

MRI is a valuable non-invasive imaging tool with high sensitivity for diagnosing fungal sinusitis. However, its moderate specificity suggests that histopathology remains the gold standard for definitive diagnosis. Future studies with larger sample sizes and advanced imaging techniques may further improve diagnostic accuracy

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