Proceedings S.Z.M.C. Vol: 40(1): pp. 70-75, 2026. *PSZMC-1017-40-1-2026*

Diagnostic Accuracy of MRI in Invasive Fungal Rhinosinusitis Affecting Diabetics taking Histopathology as Gold Standard

Sehrish Zafar[1], Iram Iqbal[2], Sana Rehman[1], Esha Habib Butt[3], Maryam Chaudhary[1], Syeda Haleema Sajid[1]

Affiliation:
[1]Services Hospital/ SIMS, Lahore, Pakistan.
[2]Punjab Institute of Cardiology, Lahore, Pakistan.
[3]Khawaja Muhammad Safdar Medical College/AIMTH, Sialkot, Pakistan..
Correspondence:
Dr. Sehrish Zafar, Assistant Professor, Services Hospital, Lahore.
E-mail: sehree83@gmail.com
Received: June 16, 2025, **Accepted:** Mar 28, 2026, **Published:** Mar 31, 2026.
DOI: https://doi.org/10.47489/szmc.v40i1.792
Data Availability: The corresponding author can provide access upon request.
Funding: No funding received
Competing Interests: No competing interest to declare.

Author Contributions:
SZ, II, SR, EHB, MC, SHS

- Each author made substantial contributions to the conception and design of the study, or acquisition, analysis, and interpretation of data.
- All authors were involved in drafting the manuscript or critically revising it for important intellect content.
- All authors approved the final version of the manuscript to be published and agree to be accountable for all aspects of the work.

ABSTRACT

Background: Diabetes is an alarmingly prevalent disease in Pakistan, affecting 26.7 % of adult population according to International Diabetic Federation (IDF). Fungal sinus infections and their complications, being dominant in immunocompromised diabetic patients, need to be diagnosed timely with MRI imaging to avoid devastating complications.
Objective: The main objective of our research is to prove diagnostic accuracy of MRI for the diagnosis of invasive fungal rhinosinusitis among diabetic, immuno-compromised patients.
Method: We performed an analytical cross-sectional study spanning ten months (May 2024 till February 2025) at the Radiology Department of Services Hospital, Lahore. Non-probability consecutive sampling technique was utilized through which 191 diabetic patients of age 35 to 50 years from both genders affected by invasive fungal rhinosinusitis were enrolled to constitute the study population. Each subject was examined using pre and post contrast MRI of paranasal sinuses, following which, histopathological confirmation was made and the results were analyzed using SPSS version 25.0 software to measure diagnostic accuracy of MRI taking histopathology as gold standard.
Results: Among the 191 diabetic patients, most of them fell in the age range of 40 to 50 years (72%) while the rest of them were aged 35 to 39 years (28%). The mean age was 42.76 years ± 5.37 years. Pre contrast MRI accompanied by Post contrast MRI has Sensitivity: 84.37%, Specificity: 88.05 %, PPV: 58.69%, NPV: 96.55 %, along with overall accuracy: 87.43 % to detect invasive fungal rhinosinusitis.
Conclusion: Magnetic resonance imaging has substantial sensitivity and specificity for diagnosing Invasive Fungal Rhinosinusitis with high degree of confidence, furthermore it pinpoints localization of extra sinus fungal invasion to provide a roadmap for surgical planning thus evading critical consequences.
Keywords: Invasive, Rhinosinusitis, Diabetics, Histopathology.

INTRODUCTION: IFRS is an aggressive fungal disease that involves nose, paranasal sinuses further spreading quickly through walls of sinuses into adjacent structures including orbit, bones, vessels and intracranial soft tissues including brain parenchyma resulting in detrimental effects [1,2]. This infection is highly prevalent in diabetic patients, due to their immunocompromised status [3,4] in developing countries like Pakistan, there is a notable surge in IFRS cases over the last two to three decades. Poor glycemic control, diabetic ketoacidosis due to undiagnosed diabetes, diabetic neuropathy, oxidative stress and diabetic vasculopathy are major risk factors to develop the fungal colonization.

Magnetic Resonance imaging (MRI) with pre-contrast and post contrast images has excellent soft tissue resolution and potential for early detection of intra-orbital and intracranial fungal extension thus it alleviates patient's morbidity and mortality [5]. Furthermore, MRI is a useful tool to monitor progression of diseases, enabling adjustments in the treatment strategies. MRI features that are crucial for identifying extra nasal, intra-orbital and intracranial extensions are evidence of similar signal intensity mass lesions in pterygomaxillary space, supplanting normal signals of extraconal fat, involvement of nasolacrimal drainage apparatus and involvement of brain parenchyma [6]. These can present with visual disturbances and neurological problems

[7]. As IFRS involves vessels, MRI can reveal their compression, loss of their normal signal voids, pseudoaneurysm formation and intraluminal filling defects in the internal carotid artery and superior ophthalmic vein with or without thrombosis of cavernous sinus [8, 9]. Further lethal complications of fungal rhinosinusitis seen on MRI include orbital/periorbital infections, meningitis, intracerebral abscess and venous sinus thrombosis. MRI excels in identifying extension to perineural regions and to cavernous sinuses both of which are severe consequences of fungal sinus disease. Fulminant fungal invasion leads to visual disturbances with high mortality among patients due to the presence of few or all of these findings [10]. As IFRS is a rapidly progressive disease in immunocompromised patients especially diabetics, delayed diagnosis of osseous involvement is the reason for documented mortality of 50 % to 80% [1]. Thus MRI is a crucial diagnostic modality which can further help clinicians to plan medical management or interventional strategy including endoscopic surgery or aggressive surgical debridement for the treatment of IFRS [11].

Histopathology is employed to verify IFRS and to meticulously identify the causative fungal strain [12]. Factors impacting the diagnostic accuracy of MRI in cases of IFRS affecting diabetic patients include accurate timing of the scan, high resolution of the MRI images, and expertise of the reporting team and comparison of results with that of histopathology. A recent local study carried out in Karachi revealed that Sensitivity of MRI for diagnosing IFRS was 82.6%, specificity 89.40%, Diagnostic Accuracy 88.30%, PPV 60.30% along with NPV 96.30% taking histopathology as the gold standard [1].

Since there is limited comparable local literature, more research is required as many of the previously available studies were done in European countries which have their own demographics. Our study focused on assessing diagnostic performance of pre and post contrast MRI in invasive fungal rhinosinusitis in diabetics of the local population with histopathologic findings taken as the reference or gold standard.

METHOD: This cross-sectional analysis was carried out at the Radiology Department of Services Hospital Lahore, for ten months between May 2024 to February 2025 with permission of the institutional review board (IRB) approval (letter Ref No. IRB/2024/1321/SIMS dated 25-04-24). To calculate the sample size as 191, the prevalence was considered as 17.8%, precision value as 58.69 %, with expected sensitivity & specificity of 82% & 89% respectively. Non-probability consecutive sampling technique was adopted to include 191 patients, with 95% confidence level and 5% margin of error. Diabetic participants who were referred to with clinical suspicion of IFRS for the imaging evaluation gave consent in writing after being fully informed. The included subjects comprised diabetic patients from both genders with age range of 35 to 50 years, with clinical suspicion of invasive fungal rhinosinusitis and having bony erosion on CT. Patients who were previously documented as primary cerebral or orbital infections & paranasal sinuses tumors, cases not fit for surgery, non-diabetics, those allergic to gadolinium contrast, and those in which MRI was contraindicated due to metallic prosthesis were excluded. All patients underwent cranial MRI including nose and sinus cavities around it on 1.5 Tesla (Canon Japan, Vantage-Titan model) MRI machine. Pre contrast images (including T1WI, T2WI, T2FAT SAT) and post contrast multiplanar images using intravenous gadolinium contrast agent were obtained. All scans were labeled as positive or negative depending upon the MRI findings of invasive fungal rhinosinusitis after evaluation by an expert radiologist. These findings were compared with histopathological findings. A preconceived proforma was used to assemble the data. The gathered data was analyzed using statistical package for social sciences SPSS version 25. Qualitative variables including diagnosis of invasive fungal rhinosinusitis using MRI and histopathology were expressed using frequency and percentages. Quantitative variables such as age and BMI were expressed through mean ± standard deviation.

RESULTS: Out of 191 patients, the mean age was calculated as 42.76 years ± 5.37 years while the age range was 35 years to 50 years. The gender distribution among the total 191 participants was 114 males (59.7 %) and 77 females (40.3 %). Their value of the BMI was 27.06 ± 3.60 kg/m^2 with minimum and maximum values of 23.46 and 30.66 kg/m^2 respectively. We calculated diagnostic accuracy of pre-contrast MRI accompanied by post-contrast MRI for IFRS along with the predictive values using histopathology as the gold standard.

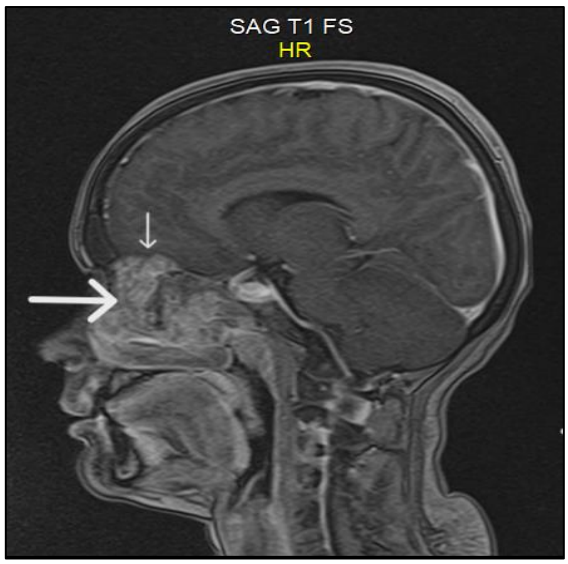

Figure 1: MRI T1 weighted sagittal post contrast image shows invasive fungal rhinosinusitis (shown by large arrow) with intracranial extension (shown by small arrow)

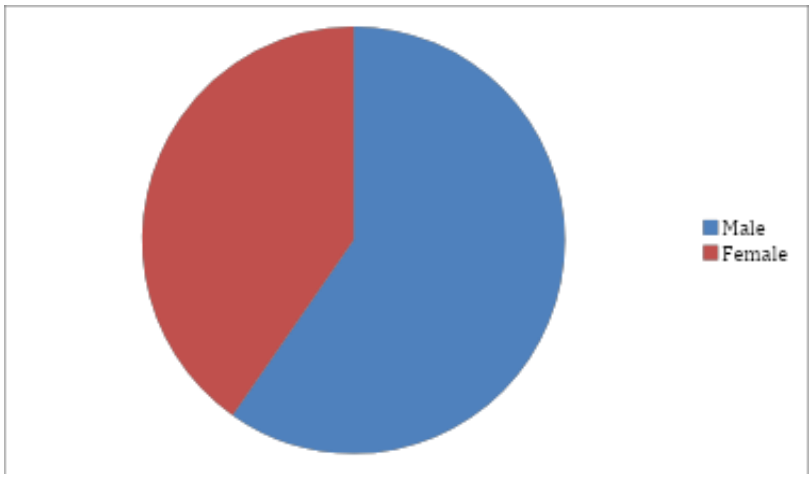

Figure 2: Pie chart representation of males and females in this study.

Table 1: Two by two table of post contrast T1W MRI to calculate sensitivity, specificity and diagnostic accuracy taking histopathology as gold standard

	Histopathology Positive (n=32)	Histopathology Negative (n=159)	TOTAL
MRI POSITIVE	27 True Positive	19 False Positive	46
MRI NEGATIVE	05 False Negative	140 True Negative	145
TOTAL	32	159	191

Sensitivity= 27/27+5 = 84.37% Specificity= 140/140+19= 88.05%
Diagnostic accuracy = 27+140/191 = 87.43%
PPV= 27/27+19 = 58.69% NPV= 140/140+5 =96.55%

Table 2: Clinical features of invasive fungal rhinosinusitis with percentages in diabetic patients

Clinical presentation	Percentage %
Headache	39 %
Altered state of consciousness	12%
Periorbital pain	54%
Facial and orbital swelling(proptosis)	56%
Nasal blockage	50%
Nasal discharge	24%
Fever	36%
Ophthalmoplegia	7%

Table 3: Complications of IFRS with percentages noted on MRI images

Complications	Percentages (%)
Orbital extension	39
Meningeal enhancement	62
Cavernous sinus involvement	06
Brain abscess	41
Cranial nerve involvement	10

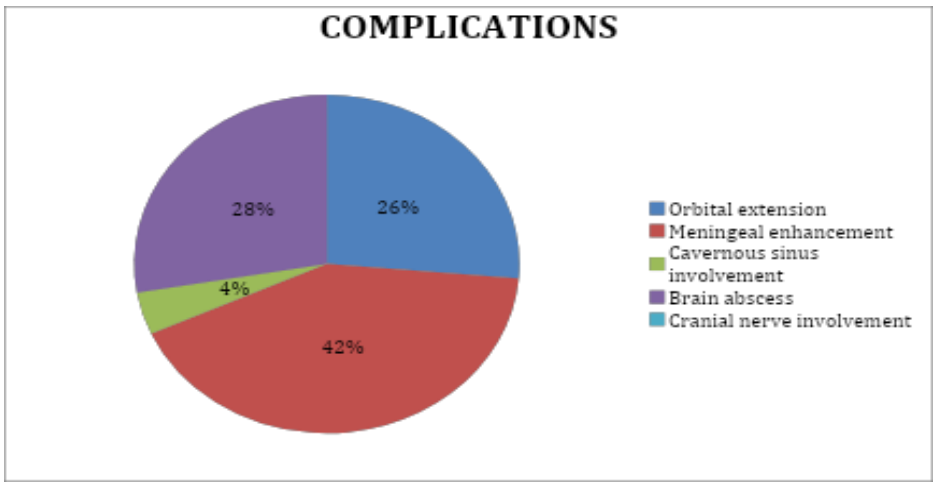

Figure 3: Pie chart representation of complications of IFRS with percentages noted on MRI images

DISCUSSION: Invasive fungal rhinosinusitis (IFRS) poses a significant life-threatening effect on diabetic immunocompromised individuals through its devastating intracranial and intra orbital complications triggering high mortality. Early diagnosis using a multidisciplinary approach is imperative for swift intervention [4]. Although widely used, CT scan often underestimates the full extent of IFRS and its primary utility lies in visualizing sinus opacification and bony erosions. Histopathology, although considered the gold standard for diagnosing IFRS, remains an invasive procedure that necessitates tissue sampling. The study underscores the enhanced diagnostic capability of MRI in identifying IFRS extension beyond the sinuses into adjacent soft tissues, orbit and brain. The results show that MRI has high sensitivity and specificity in detecting IFRS, making it the most reliable and accepted diagnostic investigation. The study also reinforces the excellent soft tissue contrast, enhanced spatial resolution of MRI and its noninvasive radiation free properties. MRI exhibits high diagnostic accuracy in our study, as fungal hyphae with paramagnetic properties appear hypo intense on both T1 and T2 weighted images with invasion of surrounding structures (Fig-I). Nevertheless, signal heterogeneity can arise from fluid and proteinaceous secretions within the paranasal sinuses [13].

In our study, MRI proved to have the sensitivity 84.37%, specificity 88.05 % and diagnostic accuracy 87.43 % for diagnosis of invasive fungal rhinosinusitis in diabetics. This shows MRI to be proficient in recognizing the true positives and true negatives. Numerous prior studies have determined MRI's comparable diagnostic precision for detecting invasive fungal rhinosinusitis. Hassan F et al. have reported the values of MRI's sensitivity 82.6%, specificity 89.40%, and diagnostic accuracy 88.30% for the diagnosis of IFRS. A study by Abokoura et al. regarding the effectiveness of MRI in IFRS found that it had a high level of accuracy, had 91.7% sensitivity and 100% specificity for detecting complications of invasion by Fungal Rhinosinusitis [12]. Patients in this research had an average age 42.76 ± 5.37 years, which differs from the study by Abokoura S et al., where it was 54.67 ± 5.26 years. This difference is largely due to the prevalence of the immunocompromised younger population in our country, consequent to high prevalence of diabetes, poor socioeconomic status and demographic differences.

Our findings on the most common clinical features of facial and orbital swelling (proptosis) found in 56% of patients in this study are consistent with those of Qazi ZU, et al. [13]. who also reported the same as the most commonly found feature. A study by Cho et al [14] also revealed concurring results and capability of MRI for extra sinus invasion with orbital involvement in 75%, pterygopalatine fossa 75%, masticator space 50%, and skull base invasion in 75%. According to Serris A, et al. there are two routes of transfer of fungal infection to brain, one is direct extension from ear or para nasal sinuses while other through blood borne spread. Blood borne spread leads to multiple brain abscesses and direct extension results in meningitis and cranial nerve palsies [15]. Diffusion weighted sequence and contrast enhanced images of MRI can positively diagnose optic nerve ischemia and myositis as discussed by Petroulia VD, et al [16] and Lever M, et al [17] While according to Lersy F, et al. [18], perineural spread is not frequently noted in patients with healthy immune system and in diagnosed cases of aspergillosis.

According to Bhatia H, et al. [19] coronal imaging of MRI helps to confirm about direct or indirect extension of infection into the cavernous sinus and its resultant thrombosis which is seen as enlargement of its size with absent internal flow voids and diffusion restriction. Our study emphasizes the pivotal role of MRI in providing the roadmap for treatment of IFRS as Patterson TF, et al. [20] also concluded that optimal approach for treating IFRS incorporates medical along with surgical intervention incorporating antifungal drugs and debridement. Debridement results in removal of dead tissue with resultant better sinus drainage and avoidance of recurrence.

CONCLUSION: MRI is indicated for early diagnosis of IFRS to reduce mortality and avoid its life-threatening complications like intracranial and intra-orbital extension with resultant thrombosis/ blockage of cavernous sinus. Our study endorses that plain and post contrast MRI sequences are best to evaluate invasive fungal rhinosinusitis in early phase of disease and to avoid extensive complications

REFERENCES

1. Hassan F, Mansoor A, Iqbal J, et al. Diagnostic accuracy of MRI in detection of invasive fungal sinusitis taking histopathology as a gold standard. Pakistan journal of Radiology 2021;31(3):171-176. https://www.researchgate.net/publication/359061714_diagnostic_accuracy_of_mri_in_detection_of_invasive_fungal_sinusitis_taking_histopathology_as_a_gold_standard
2. Erami M, Aboutalebian S, Hezaveh SJH, Ghazvini RD, Momen-Heravi M, Jafari Y, et al. Microbial and clinical epidemiology of invasive fungal rhinosinusitis in hospitalized COVID-19 patients, the divergent causative agents. Medical Mycology 2023;61(3):myad020. https://doi.org/10.1093/mmy/myad020
3. Taghian E, Abtahi SH, Mohammadi A, Hashemi SM, Ahmadikia K, Dolatabadi S, Mohammadi R. A study on the fungal rhinosinusitis: Causative agents, symptoms, and predisposing factors. J Res Med Sci. 2023;28:12. DOI:10.4103/jrms.jrms_270_22
4. Yağmur AR, Çufalı ÖF, Çolak M, et al. Invasive fungal rhinosinusitis, clinical manifestations, and prognostic values: as case series audit. Egypt J Otolaryngol 2023;39:189. DOI:10.1186/s43163-023-00551-8
5. Lai J, Wang B, Petrik M, Beziere N, Hammoud DA, Radiotracer Development for Fungal-Specific Imaging: Past, Present, and Future. The J of Inf Dis 2023;228(4):259-269. https://doi.org/10.1093/infdis/jiad067. DOI:10.1093/infdis/jiad067
6. Kondapavuluri SK, Anchala VKR, Bandlapalli S, Gorantla R, Danaboyina AR, Kondapavuluri BK, Mandalapu S. Spectrum of MR imaging findings of sinonasal mucormycosis in post COVID-19 patients. Br J Radiol 2021;94(1127):20210648. https://doi.org/10.1259/bjr.20210648
7. Huang YF, Liang KL, Liang CY, Yang PC, Chen JP, Wei LC. Acute invasive fungal rhinosinusitis-related orbital infection: a single medical center experience. Journal of Ophthalmology 2021;12:1-8. DOI:10.1155/2021/9987871
8. Idowu OO, Karl A, Soderlund KA, Laguna B, Davin C, Ashraf DC, Benjamin F, Arnold BF, Seanna R, Grob SR, et al. Magnetic Resonance Imaging Prognostic Findings for Visual and Mortality Outcomes in Acute Invasive Fungal Rhinosinusitis. Am J ophthalmol. 2022;129(11):1313-1322. DOI:10.1016/j.amjopt.2022.06.017
9. Chen A, Pietris J, Bacchi S, Chan W, Psaltis AJ, Selva D, Lim WY. Imaging Features of Invasive Fungal Rhinosinusitis: A Systematic Review. Canadian Association of Radiologists Journal 2024;75(3):601–608. doi: 10.1177/08465371241227424.
10. 10 Kovanda LL, Marty FM, Maertens J, et al. Impact of mucositis on absorption and systemic drug exposure of isavuconazole. Antimicrob Agents Chemother. 2017;61(6):101-17. doi: 10.1128/AAC.00101-17.
11. Roland LT, Humphreys IM, Le CH, Babik JM, Bailey CE, Ediriwickrema LS, et al. Diagnosis, prognosticators, and management of acute invasive fungal rhinosinusitis: multidisciplinary consensus statement and evidence-based review with recommendations. International Forum of Allergy & Rhinology 2023;13(9):1615-1714. doi: 10.1002/alr.23132
12. Abokoura S, Youssef A, Nada A, et al. Magnetic resonance imaging manifestations of vascular complications in patients with acute invasive fungal rhinosinusitis. Egypt J Radiol Nucl Med 2023;54:133. doi: 10.1186/s43055-023-01081-2
13. Qazi ZU, Latif S, Awan SM. Orbital involvement in sinonasal diseases. J Ayub Med Coll Abbottabad 2016;28(4):687-693.https://www.ayubmed.edu.pk/jamc/index.php/jamc/article/view/1189
14. Cho SJ, Choi YJ, Cho KJ, et al. Image findings in patients with chronic invasive fungal infection of paranasal sinuses. J Neuroradiol. 2021;48(5):325-330. doi: 10.1016/j.neurad.2021.02.005
15. Serris A, Benzakoun J, Danion F, et al. Cerebral aspergillosis in the era of new antifungals: The CEREALS national cohort study Nationwide Cerebral Aspergillosis Lesional study (CEREALS). J Infect 2022;84(2):227–236. doi: 10.1016/j.jinf.2021.11.014
16. Petroulia VD, Brügger D, Hoepner R, et al. MRI signs helpful in the differentiation of patients with anterior ischaemic optic neuropathy and optic neuritis. Br J Ophthalmol 2023;107:121-126. doi: 10.1136/bjophthalmol-2021-319537
17. Lever M, Wilde B, Pförtner R, et al. Orbital aspergillosis: a case report and review of the literature. BMC Ophthalmol 2021;21(1):22. doi: 10.1186/s12886-020-01773-7
18. Lersy F, Royer-Leblond J, Lhermitte B, et al. Cerebral mucormycosis: neuroimaging findings and histopathological correlation. J Neurol 2022;269(3):1386–1395.https://doi.org/10.1007/s00415-021-10701-8
19. Bhatia H, Kaur R, Bedi R. MR imaging of cavernous sinus thrombosis. Eur J Radiol Open 2020;7:100226. doi: 10.1007/s00415-021-10701-8.
20. Patterson TF, Thompson GR3rd, Denning DW, et al. Practice guidelines for the diagnosis and management of aspergillosis: 2016 update by the infectious diseases society of America. Clin Infect Dis 2016;63(4):1–60. doi:10.1093/cid/ciw326.

The Authors:

- Sehrish Zafar, Assistant Professor Radiology, Services Hospital, Lahore, Pakistan.
- Iram Iqbal, Professor of Radiology, Punjab Institute of Cardiology, Lahore, Pakistan.
- Sana Rehman, Senior Registrar Radiology, Services Hospital, Lahore, Pakistan.
- Esha Habib Butt, Associate Professor, Khawaja Muhammad Safdar Medical College/AIMTH, Sialkot, Pakistan..
- Maryam Chaudhary, Senior Registrar Radiology, Services Hospital, Lahore, Pakistan.
- Syeda Haleema Sajid, MBBS Post Graduate Trainee, Services Hospital, Lahore, Pakistan.