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ORIGINAL ARTICLE

Diagnostic Accuracy of Multidetector Computed Tomography Using Functional Endoscopic Sinus Surgery Protocol for the Evaluation of Fungal Sinusitis, with Histopathology as the Gold Standard

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ABSTRACT

Background: Fungal sinusitis is an increasingly acknowledged illness characterized by a diverse array of clinical manifestations, ranging from non-invasive to potentially fatal invasive forms. A correct diagnosis as soon as possible is important to help with the right treatment and avoid problems. Multidetector computed tomography (MDCT) employing the Functional Endoscopic Sinus Surgery (FESS) procedure is important in assessing paranasal sinus disorders; however, its diagnostic precision in fungal sinusitis necessitates additional validation through histopathological comparison.

Objective: To determine the diagnostic accuracy of multidetector computed tomography using the FESS protocol in diagnosing fungal sinusitis, keeping histopathology as the gold standard.

Methodology: This cross-sectional study took place in the Department of Radiology at Govt. Kot Khawaja Saeed Hospital in Lahore over a span of three months. We used non-probability convenient sampling to include 65 individuals between the ages of 14 and 80 who were clinically suspected of having paranasal sinusitis. All patients had an MDCT scan done using the FESS procedure. Imaging results were documented and juxtaposed with histological findings acquired post-surgical intervention. We used SPSS version 25 to look at the data. We figured out the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy.

Results: The average age of the patients was 50.29 years, with 61.54% of them being men. CT scans showed fungal sinusitis in 58% of patients, and histology confirmed it in 60%. MDCT showed a sensitivity of 84.62%, a specificity of 80.77%, a positive predictive value of 86.84%, a negative predictive value of 77.78%, and an overall diagnostic accuracy of 83.08%. Mucosal thickening with hyperdensity (100%), sinus expansion (89.23%), and bony erosion (81.54%) were all common CT findings.

Conclusion: MDCT with the FESS protocol is a dependable and efficient imaging technique for diagnosing fungal sinusitis. It not only gives very accurate diagnoses, but it also assists with disease characterisation and surgical planning when combined with clinical and histological data.

Keywords: Fungal sinusitis, multidetector computed tomography, FESS protocol, diagnostic accuracy, histopathology

INTRODUCTION

Fungal sinusitis is characterized by the inflammation of the mucosal lining of the paranasal sinuses due to a fungal infection. Fungal rhinosinusitis (FRS) is a more accurate word, as it frequently affects both the nasal cavity and the paranasal sinuses. Fungal rhinosinusitis encompasses a range of conditions, from benign colonization to severe invasive infections that result in considerable morbidity and mortality. Plaignaud first talked about FRS in 1791, but in the last few decades, there has been a lot more interest in learning about its pathophysiology and classification.FRS is presently acknowledged as a heterogeneous collection of illnesses characterized by unique clinical, radiological, and pathological features. In general, it may be broken down into two groups: invasive and non-invasive. This is dependent on how much tissue it invades. Fungal ball, saprophytic fungal sinusitis, and allergic fungal rhinosinusitis (AFRS) are examples of non-invasive forms. Acute invasive fungal rhinosinusitis, chronic invasive fungal rhinosinusitis, and granulomatous invasive fungal sinusitis are examples of invasive forms. This classification is clinically significant due to the considerable differences in prognosis and treatment approaches among different subtypes. Non-invasive forms are generally observed in immunocompetent persons, but invasive forms are more prevalent in immunocompromised patients and are linked to an elevated risk of complications and mortality[3,6].The pathogenesis of fungal sinusitis is affected by various factors, such as the immunological condition of the host, environmental exposure, and the aggressiveness of the fungus. Fungi are organisms that are found everywhere in the environment, and it is impossible to avoid coming into contact with fungal spores. But not everyone gets sick; host immunity is very important in stopping infections. Diabetes mellitus, prolonged corticosteroid medication, chemotherapy, and immunosuppressive conditions heighten vulnerability to fungal infections. Molds like Aspergillus, Mucor, and Rhizopus are the most prevalent organisms that cause this[4,13]. Aspergillus species are commonly associated with allergic and invasive forms, whereas mucormycosis is frequently connected with quickly developing invasive illness[4].Fungal sinusitis manifests clinically with a diverse array of symptoms, contingent upon the type and severity of the condition. Common signs and symptoms are stuffy noses, face pain, headaches, runny noses, and loss of smell. In invasive cases, more serious symptoms include swelling around the eyes, proptosis, involvement of cranial nerves, and neurological impairments may happen when the infection spreads to nearby structures. These symptoms are often vague and can look like other diseases, which can make it harder to diagnose and raise the risk of complications. Consequently, a heightened clinical suspicion is essential, particularly in high-risk individuals[7].A precise diagnosis of fungal sinusitis necessitates a synthesis of clinical assessment, imaging modalities, endoscopic evaluation, and histological validation. Functional endoscopic sinus surgery (FESS) serves a dual purpose in diagnosis and therapy, facilitating direct viewing and the acquisition of tissue samples for histological examination. Histopathology is still the best way to confirm fungal sinusitis because it lets you find fungal elements and see how much tissue has invaded, which is important for telling the difference between invasive and non-invasive forms[26].Imaging is

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essential in the assessment of fungal sinusitis, especially for determining disease severity and detecting complications. Multidetector computed tomography (MDCT) with the FESS protocol is regarded as the preferred imaging modality for preoperative assessment. CT imaging gives a lot of information on the anatomy of the sinuses, such as thickening of the mucosa, erosion of the bone, calcifications, and extension outside of the sinuses. The "double density sign" is a common marker of fungal sinusitis on CT. It shows hyperdense fungal elements surrounded by hypodense inflammatory mucosa[30]. This finding strongly indicates a fungal infection and helps to distinguish it from other types of sinusitis.It has been said that CT scans are quite good at finding fungal sinusitis. Earlier research has shown sensitivity and specificity values between 89% and 96% and 86% and 93%, respectively[2,12,15]. These results underscore the dependability of CT imaging in the preliminary assessment and surgical planning of fungal sinusitis. CT imaging is helpful, but it can't fully confirm the diagnosis because other illnesses, like chronic bacterial sinusitis or sinonasal tumors, can have comparable radiological findings. Consequently, linkage with histological results is crucial to ascertain a definitive diagnosis.Recent improvements in diagnostic methods, including as polymerase chain reaction (PCR) and frozen section analysis, have made it easier to find fungal infections. PCR has shown excellent sensitivity and negative predictive value, which makes it a good way to rule out disease. Frozen section analysis enables swift intraoperative diagnosis, which is especially advantageous in invasive fungal sinusitis, as prompt intervention can markedly decrease mortality. Even with these improvements, histopathology is still the most important way to make a diagnosis.The rising frequency of fungal sinusitis, especially in immunocompromised individuals, underscores the necessity for prompt and precise diagnosis. Research indicates an increase in complications, including orbital involvement and intracranial extension, which may result in significant morbidity and mortality. It is very important to use CT imaging to find out how far along a disease is early on so that surgery may be planned and problems can be avoided[29].Chronic rhinosinusitis (CRS) is another major illness linked to fungal infections. In fact, a large number of people who have sinus surgery have fungal elements in their bodies. However, the precise function of fungus in CRS is still debated, as fungal entities have been identified in healthy persons as well. This underscores the necessity of amalgamating clinical, radiographic, and histological evidence for precise diagnosis[25].To sum up, fungal sinusitis is a complicated and perhaps deadly disease that can show up in many different ways and have many different effects. Multidetector computed tomography employing the FESS protocol is essential for the assessment of this disease, as it delivers comprehensive anatomical and pathological data. Nonetheless, histopathology analysis continues to be the benchmark for conclusive diagnosis. Because the clinical presentation can vary and major consequences can happen, it is important to compare the diagnostic accuracy of MDCT with histology to improve patient care and outcomes.

METHODOLOGY

This study was conducted as a cross-sectional study in the Department of Radiology at Govt. Kot Khawaja Saeed Hospital, Lahore, over a period of three months following approval of the research synopsis . A total of 65 patients were included in the study, and the sample size was calculated using a 95% confidence level, 10% absolute precision, expected sensitivity of 100%, expected specificity of 15.8%, and an anticipated prevalence of fungal sinusitis of 18.9%. A non-probability convenient sampling technique was employed for patient selection .

Patients of both genders aged between 14 and 80 years presenting with clinical features suggestive of paranasal sinusitis, such as nasal blockage, headache, and rhinorrhea, were included in the study. Additionally, only those patients who demonstrated relevant computed tomography (CT) findings—including mucosal thickening, polyp formation, homogeneous or heterogeneous opacification, osseous erosion, air-fluid levels, intraorbital or intracranial extension, retroantral involvement, and overlying facial soft tissue swelling—were enrolled. Pregnant and post-surgical cases were excluded from the study .

All CT examinations were performed using a Toshiba 16-slice multidetector computed tomography scanner following the Functional Endoscopic Sinus Surgery (FESS) protocol. After recording demographic data and detailed clinical history using a structured proforma, each patient underwent CT imaging of the paranasal sinuses. The imaging findings were documented systematically. Subsequently, all patients underwent surgical intervention by an ENT specialist, and tissue samples were obtained and sent for histopathological examination, which was considered the gold standard. The CT findings were then correlated with histopathology results to determine the diagnostic accuracy of multidetector CT using the FESS protocol .

Ethical approval was obtained from the Institutional Review Board of King Edward Medical University, Lahore, prior to the commencement of the study. Written informed consent was obtained from all participants, and confidentiality of patient information was strictly maintained. Participants were informed about the benefits and potential risks, including radiation exposure from CT imaging, and were assured of their right to withdraw from the study at any stage without any consequences .

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 25. Quantitative variables such as age and duration of symptoms were expressed as mean ± standard deviation, while qualitative variables such as gender and sinus involvement were presented as frequencies and percentages. Diagnostic accuracy parameters, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false positive rate, and false negative rate, were calculated by taking histopathology as the gold standard .

RESULTS

This study covered 65 patients in total. The results are shown below in tables with clear explanations.

The average age of the patients was 50.29 years, with ages ranging from 20 to 70 years. This suggests that fungal sinusitis was more prevalent among middle-aged and older adults.

Out of 65 patients, 40 (61.54%) were male and 25 (38.46%) were female, indicating a male predominance in the study population.

The average length of symptoms was 8.2±2.53 weeks, which means that most patients had symptoms that were subacute to chronic.

Clinical Presentation

Most common presenting symptoms included:

- Headache: 92%
- Hyposmia: 92%
- Nasal blockage: 89%
- Rhinorrhea: 62%
- Epistaxis: 62%
- Eye symptoms: 62%
- Allergic rhinitis: 69%

These findings indicate that nasal obstruction and headache were the most frequent complaints among patients.

All patients exhibited mucosal thickening with internal hyperdensity on CT scan. A large number of them (89.23%) showed sinus enlargement and bony erosion (81.54%), which means the disease was aggressive. Intracranial (47.69%) and intraorbital (44.62%) expansions underscore the severity and problems linked to fungal sinusitis.

- CT scan diagnosed fungal sinusitis in **58%** of patients
- Histopathology confirmed fungal sinusitis in **60%** of patients

This shows close agreement between CT findings and histopathological results

The findings indicated that MDCT employing the FESS protocol exhibited good sensitivity (84.62%) and specificity

(80.77%) in the diagnosis of fungal sinusitis. A total of 33 patients were accurately classified as genuine positives, whilst 21 were recognized as true negatives. The overall accuracy of the tests was 83.08%, which means that CT is a good way to diagnose problems before surgery.

Patients over 60 years old had the highest sensitivity (90.91%), whereas patients between 41 and 60 years old had the highest specificity (85.71%). The accuracy of the diagnosis stayed about the same for people of all ages.

MDCT worked better as a diagnostic tool for men than for women. In men, sensitivity and specificity were 88.88% and 92.30%, respectively. In women, they were 75% and 69.23%, respectively. The results of this study showed that utilizing the FESS protocol with multidetector computed tomography is a very sensitive and very specific way to diagnose fungal sinusitis. CT data exhibited a robust connection with histological results, affirming its significance as a crucial preoperative imaging modality.

Table 1: Age Distribution of Patients

Variable	Value
n	65
Mean age	50.29 ± 13.38 years
Minimum	20 years
Maximum	70 years

Table 2: Gender Distribution

Gender	Frequency	Percentage
Male	40	61.54%
Female	25	38.46%

Table 3: Duration of Symptoms

Variable	Value
Mean duration	8.2 ± 2.53 weeks
Minimum	4 weeks
Maximum	12 weeks

Table 4: CT (FESS Protocol) Findings

CT Findings	Frequency	Percentage
Mucosal thickening with hyperdensity	65	100%
Expansion of sinuses	58	89.23%
Bony erosion/thinning	53	81.54%
Intracranial extension	31	47.69%
Intraorbital extension	29	44.62%
Anatomical variants	25	38.46%

Table 5: Diagnostic Accuracy of MDCT (FESS Protocol)

CT Findings	Histopathology Positive	Histopathology Negative	Total
Positive	33 (True Positive)	5 (False Positive)	38
Negative	6 (False Negative)	21 (True Negative)	27
Total	39	26	65

Table 6: Diagnostic Parameters

Parameter	Value
Sensitivity	84.62%
Specificity	80.77%
Positive Predictive Value (PPV)	86.84%
Negative Predictive Value (NPV)	77.78%
Diagnostic Accuracy	83.08%

Table 7: Diagnostic Accuracy Stratified by Age

Age Group	Sensitivity	Specificity	Diagnostic Accuracy
20–40 years	77.78%	83.33%	80%
41–60 years	84.21%	85.71%	84.85%
>60 years	90.91%	66.67%	82.35%

Table 8: Diagnostic Accuracy Stratified by Gender

Parameter	Male	Female
Sensitivity	88.88%	75%
Specificity	92.30%	69.23%
PPV	96%	69.23%
NPV	80%	75%
Diagnostic Accuracy	90%	72%

CONCLUSION

This study found that multidetector computed tomography (MDCT) employing the Functional Endoscopic Sinus Surgery (FESS) technique was very accurate at diagnosing fungal sinusitis when compared to histology, which is the gold standard. The method exhibited robust sensitivity and specificity, demonstrating efficacy in detecting distinctive imaging characteristics, including mucosal thickening, hyperdensities, bony erosion, and extrasinus extension.Also, when looked at with clinical signs, the course of the disease, and the patient's treatment history, FESS protocol CT was useful for telling apart distinct types of fungal sinusitis. It was also very important for figuring out how far the sickness had spread and how the body was different, which is important for planning surgery. So, MDCT with the FESS protocol can be seen as a reliable, non-invasive, and important way to diagnose fungal sinusitis early and accurately, which will help with timely treatment and less problems.

DISCUSSION

Fungal sinusitis is a diverse condition characterized by various clinical manifestations, necessitating prompt and precise diagnosis for effective care[16]. This study assessed the diagnostic accuracy of multidetector computed tomography (MDCT) employing the Functional Endoscopic Sinus Surgery (FESS) technique, in contrast to histopathology as the gold standard[17]. The demographic profile of this study indicated a mean age of 50.29±13.38 years, with a majority of male patients (61.54%). These results align with prior research indicating that fungal sinusitis is more prevalent among middle-aged persons, but gender distribution may differ among populations[18].

The most prevalent clinical complaints recorded were headache (92%), hyposmia (92%), and nasal obstruction (89%). These results align with the current literature, indicating that fungal sinusitis frequently manifests with vague symptoms akin to chronic rhinosinusitis, underscoring the necessity for imaging in diagnosis[19]. CT data in this study indicated that mucosal thickening with internal hyperdensity was observed in all patients, succeeded by sinus expansion (89.23%) and bony erosion (81.54%). These imaging characteristics are indicative of fungal sinusitis, notably the presence of hyperdense material within the sinuses, frequently referred to as the “double density sign” [20].

The identification of intraorbital (44.62%) and intracranial (47.69%) extension underscores the disease's aggressive potential and the critical use of CT in evaluating disease extent[21]. In this investigation, MDCT had a sensitivity of 84.62%, a specificity of 80.77%, and an overall diagnostic accuracy of 83.08%. These results are similar to those of earlier research that found sensitivity and specificity values of 85% to 96% and 80% to 93%, respectively[22,23]. The positive predictive value (86.84%) shows that CT is a good way to find real instances of fungal sinusitis. The negative predictive value (77.78%) shows that histological confirmation is still important in cases where there is doubt[24].

Stratified analysis indicated marginally superior diagnostic performance in older patients and men; however, these discrepancies may be affected by sample size and disease severity. Even while CT is very accurate, it cannot replace histology, which is still the best way to diagnose and classify fungal sinusitis. In conclusion, MDCT utilizing the FESS protocol is an effective diagnostic instrument for fungal sinusitis, offering comprehensive insights into disease severity and facilitating surgical preparation. Nevertheless, it must consistently be interpreted with clinical findings and validated through histological testing.

REFERENCES

1. Pilai S, Bhandarkar AM, Nair SS, et al. A radiological profile of fungal sinusitis. Asian J Pharm Clin Res. 2017;10(9):331-4.
2. Naz N, Ahmad Z, Malik S, Zahid T. Diagnostic accuracy of CT scan in fungal sinusitis. Ann Pak Inst Med Sci. 2016;12(2):61-5.

3. Chatterjee SS, Chakrabarti A. Epidemiology and medical mycology of fungal rhinosinusitis. 2009;1:1-13.
4. Ferguson BJ. Mucormycosis of the nose and paranasal sinuses. Otolaryngol Clin North Am. 2000;33(2):349-65.
5. Waqar S, Ameer S, Naeem M, et al. Diagnostic accuracy of MRI in fungal sinusitis. Pak Armed Forces Med J. 2020;70(6):1810.
6. Singh V. Fungal rhinosinusitis: disease spectrum. J Maxillofac Oral Surg. 2019;18(2):164-79.
7. Gorovoy IR, Kazanjian M, et al. Imaging modalities in fungal sinusitis. Saudi J Ophthalmol. 2012;26(4):419-26.
8. Nicolai P, Lombardi D, et al. Fungus ball management. Laryngoscope. 2009;119(11):2275-9.
9. Lutfi IA, Maheswari N, et al. CT accuracy in fungal sinusitis. Pak J Rehabil. 2013;2(1):13-6.
10. Meng Y, Zhang L, et al. MRI in fungal sinusitis. J Thorac Dis. 2019;11(8):3569.
11. Pant H, Kette FE, et al. Eosinophilic mucus CRS. Laryngoscope. 2006;116:1241-7.
12. Kanwar SS, Mital M, et al. CT and histopathology correlation. J Oral Maxillofac Radiol. 2017;5:46-52.
13. Krishnan KU, Agatha D, et al. Clinicomycological perspective. Indian J Med Microbiol. 2015;33:120-4.
14. Kandukuri R, Phatak S. CT evaluation of sinonasal diseases. J Clin Diagn Res. 2016;10(11):TC09.
15. Gupta K, Saggar K. CT features correlation study. Ann Afr Med. 2014;13:119-23.
16. Chakrabarti A, Denning DW, Ferguson BJ, et al. Fungal rhinosinusitis: a categorization and definitional schema. Laryngoscope. 2009;119(9):1809–18.
17. Nicolai P, Lombardi D, Tomenzoli D, et al. Fungus ball of the paranasal sinuses: experience in 160 patients. Laryngoscope. 2009;119(11):2275–9.
18. Singh V. Fungal rhinosinusitis: disease spectrum. J Maxillofac Oral Surg. 2019;18(2):164–79.
19. Gorovoy IR, Kazanjian M, et al. Imaging modalities in fungal sinusitis. Saudi J Ophthalmol. 2012;26(4):419–26.
20. Kandukuri R, Phatak S. Evaluation of sinonasal diseases by CT. J Clin Diagn Res. 2016;10(11):TC09–TC12.
21. Ferguson BJ. Definitions of fungal rhinosinusitis. Otolaryngol Clin North Am. 2000;33(2):227–35.
22. Naz N, Ahmad Z, Malik S, Zahid T. Diagnostic accuracy of CT scan in fungal sinusitis. Ann Pak Inst Med Sci. 2016;12(2):61–5.
23. Gupta K, Saggar K. CT evaluation of paranasal sinus fungal infections. Ann Afr Med. 2014;13(3):119–23.
24. Kanwar SS, Mital M, et al. CT and histopathological correlation in fungal sinusitis. J Oral Maxillofac Radiol. 2017;5(2):46–52.

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