Original Article
DOI: https://doi.org/10.70749/ijbr.v4i4.3027

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Crossref
OPEN ACCESS

Radiological Comparison of X-ray and Computed Tomography in Diagnosing Fungal Sinusitis and Nasal Polyps

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ARTICLE INFO

Keywords: Radiological Comparison, Diagnosis, Fungal Sinusitis, Nasal Polyps, HRCT, X-ray, Diagnostic Accuracy.

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Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 06-03-2026 Revised: 11-04-2026
Accepted: 16-04-2026 Published: 26-04-2026

ABSTRACT

Introduction: Sinonasal diseases, mainly fungal sinusitis and nasal polyps, are found in a large percentage of chronic rhinosinusitis and have an important impact on patient quality of life. Early management and prevention of complications depend on accurate radiological diagnosis. Plain X-ray of Paranasal Sinuses (PNS) is commonly made more due to availability, being relatively less expensive; the Computed Tomography (CT) provides better anatomic characterization and is the basis of comparison for sino-nasal assessment. **Objective:** To evaluate radiological comparison of X-Ray and Computed Tomography in diagnosing Fungal Sinusitis and Nasal Polyps. **Methodology:** The study was a cross-sectional analytical study comprises of 60 patients of both sexes male/female between 12 to70 years suspected with fungal sinusitis or nasal polyp are included. Both X-ray PNS and CT-PNS were performed in all subjects. Results of imaging were correlated with endoscopy and histopathological diagnosis (gold standard). SPSS version 26 was used to measure sensitivity, specificity, PPV, NPV and the diagnostic accuracy. **Results:** The diagnosis of fungal sinusitis was made in 46.7% patients, and nasal polyps in 36.7%. X-ray had marginal sensitivity (64.3%) and specificity (70.8%), with overall accuracy of 67.5 %. On CT, the sensitivity and specificity were significantly higher (92.9% and 90.9%, respectively) with a diagnostic accuracy of 91.7% ($p < 0.001$). CT efficiently demonstrated typical signs including heterogeneous opacity, hyper attenuation foci, double-density sign and bone erosion. **Conclusion:** CT scan is far more accurate than X-ray in the diagnosis of fungal sinusitis and its distinction from nasal polyps. While X-ray might be used as a primary screening modality, CT is the optimal choice for final diagnosis and surgical planning.

INTRODUCTION

The paranasal sinuses are air-filled cavities present within the facial bones and the base of the skull around the nasal cavity. There are four paired sinuses, each draining into the nasal cavity through small channels. These include the frontal, ethmoidal, maxillary, and sphenoid sinuses. Normal function of the paranasal sinuses depends on three key components: thin mucus secretions, properly functioning cilia that help move mucus out of the sinuses, and patent sinus drainage openings known as the sinus ostia. Any condition such as inflammation, tumors, or foreign bodies that obstructs sinus drainage can make the sinus prone to infection [1]. Chronic rhinosinusitis (CRS) represents one of the most prevalent eye-nose-throat (ENT) disorders worldwide, significantly affecting patient quality of life and productivity. Disorders of the paranasal sinuses are frequently encountered in clinical practice and account for a significant number of visits to otorhinolaryngology clinics. Fungal sinusitis and Nasal polyps are exceptionally significant because of their chronic in nature, tendency to recurrence and possibility to cause serious complications if not diagnosed precisely. Early identification of the disease is significant for effective treatment and to avoid further complications [2]. Gross polyps manifest as pale, edematous tissue sacs that typically originate from the middle meatus and protrude into the nasal cavity. Poor blood flow is the cause of their pale hue, but with repeated damage and inflammation, polyps may turn red and develop a squamous surface instead of a respiratory one. They are typically bilateral and when they are unilateral, a histological study is necessary to rule out malignancy or transitional cell papilloma (also called Ringertz's tumor or inverted papilloma) [3]. Etiology of sino-nasal polyps (SNP) is unknown. Most theories consider polyps a consequence of chronic inflammation and therefore conditions leading to

chronic inflammation in the nasal cavity can lead to nasal polyps. Anatomic factors may also play a role in the etiology of SNP as nasal polyps are mainly situated in the middle meatus and that they originate from the mucous membrane of the outlets (ostia, clefts, recesses) from the paranasal sinuses. The reason for this is unknown [4]. Their main presenting symptom is nasal obstruction, which is constant, although it was vary with the size and position of polyps. Patients may also complain of watery anterior rhinorrhea (excessive nasal secretions) or mucopurulent postnasal drip, or both. Hyposmia and anosmia (reduced or absent sense of smell) with a concomitant alteration in taste are characteristic symptoms of nasal polyps. Pain is an infrequent feature but does occur in patients with polyps and is usually over the dorsum of the nose, forehead and cheeks. It is worse when the nose is congested and there is secondary infection of the sinuses [5]. Nasal polyps are defined as benign, edematous mucosal protrusions originating from the paranasal sinuses or nasal cavity. Nasal polyps are semi-translucent mucosal out-growths of the para nasal sinuses which typically arise in the setting of chronic rhinosinusitis (CRS). Chronic rhinosinusitis (CRS) represents one of the most prevalent ENT disorders worldwide, significantly affecting patient quality of life and productivity [6]. Fungal sinusitis is an inflammation of the sinuses caused by fungi. Aspergillus and Mucorales are the most common fungi to cause acute invasive fungal sinusitis (AIFS) [7]. Noninvasive fungal rhinosinusitis includes allergic fungal rhinosinusitis (AFRS) and fungus ball (FB). Fungal balls (FB) are non-invasive collections of fungal mycelia in sinuses. Instead of the fungus itself, the host immune status usually determines the presentation of the disease. Host immune response and interactions between bacteria and fungi contribute to different manifestations of rhinosinusitis [8]. The exact pathophysiology of AFS is unknown. A common fungus is most likely exposed to some people who have abnormally thick mucus and underlying osteomeatal complex disease. In the susceptible person, the fungal spores then multiply. While an atopic patient experiences an immunological response that intensifies the development of AFS, a nonatopic patient may subsequently develop a mycetoma [9]. The treatment of AIFS requires surgery, antifungal therapy, and reversal of immunosuppression. Among CRS patients, fungal sinusitis has emerged as an increasingly recognized clinical burden, linked to climatic, environmental, and immunological factors [10]. Fungal involvement of the paranasal sinuses exists across a spectrum, broadly classified as non-invasive types such as allergic fungal rhinosinusitis (AFRS) and fungal balls, and invasive types that include acute and chronic invasive fungal sinusitis. Parallel to this, nasal polyp continues to exist as a major problem of chronic rhinosinusitis caused by chronic inflammation of nasal mucosa, promoting to nasal obstruction, anosmia and frequent infections [11]. Due to COVID-19 pandemic, increased cases of invasive fungal sinusitis was seen especially mucormycosis in diabetic and immune compromised patients. Therefore, timely and precisely radiological examination is significant because delayed identification can lead to the risk of orbital extension, intracranial spread and other life threatening complexities [12]. Radiological imaging plays an essential role in diagnosing and characterization of fungal sinusitis form sino-nasal polyp. As plain X-ray is easily available and cost effective but it shows limited sensitivity for sinus pathologies and sinus [13]. Generally, X-ray PNS is the initial step for diagnosing PNS lesions but it is not enough to reach at the final diagnosis. Because plain X-ray were do not provide enough information for pre surgical planning. Although with some limitations, when CT is not available; X-ray still detects sino-mucosal thickenings, opacifications and air fluid levels [14]. High resolution Computed Tomography has become a gold standard for diagnosing pathologies of para nasal sinuses. As CT provide good spatial resolution, assess bone degeneration and OMC obstruction. Moreover, CT accurately shows features of fungal sinusitis such as heterogeneous hyperdensities, sinus calcifications and sinus extension [15]. Plain radiographs of the highest quality cannot even detect the presence and extent of soft tissue disease and bone erosion. CT scan can provide more detailed information about the anatomy and abnormalities of the paranasal sinuses than plain radiographs especially pathologies within the sphenoid and ethmoid sinuses [16]. Because of this, computed tomography (CT) is a crucial preoperative test that complements diagnosis and treatment of paranasal sinus and nasal cavity disorders. Simple radiographs are not very useful for functional endoscopic sinus surgery due to Overlying structures obscure the sinus walls. It is feasible to identify paranasal mucosal abnormalities and bony variations. Sinuses with CT were making anatomical variations of the bone, which have been linked to recurrent and persistent sinusitis [17]. Nasal polyps present as smooth soft-tissue masses without hyperdense debris but contribute to OMC obstruction and secondary sinusitis [18]. The CT scoring system of Lund-Mackey was widely acceptable for calculating chronic rhino-sinusitis severity and relating images with treatment planning. The primary dominant way in Pakistan was X-Ray because of cost and reachability. Therefore, various patients face delayed CT based examinations that affect their results or patient outcomes[19].There is an increase need for valid evidence to enhance the diagnostic approaches for comparative effectiveness of X-ray and CT in the early assessment of fungal sinusitis and nasal polyps in resource limited settings. Identifying how often radiography fails to detect the clinically important information helps to improves strategies and prevents serious complications [20].In Pakistan, regardless of increasing prevalence of fungal sinusitis, there is lack of diagnostic accuracy studies. Most clinical decisions still based on clinical symptoms rather than radiology evaluation [21].

Objectives

To evaluate radiological comparison of X-Ray and Computed Tomography in diagnosing Fungal Sinusitis and Nasal Polyps.

MATERIALS AND METHODS

This cross-sectional analytical investigation was carried out at Faisal Hospital, over the course of four months. Based on a 4% [22] prevalence rate, a 5% margin of error, and a 95% confidence level (Z = 1.96), the anticipated sample size was 60 individuals. To choose participants, a practical sampling method was used. Patients between the ages of 12 and 70 who had an ENT specialist's clinical suspicion of fungal sinusitis or nasal polyps, underwent both X-ray PNS and CT PNS within 30 days, and gave their informed consent were included in the study. Patients were excluded if they had a history of sinonasal surgery, sinonasal cancer, significant facial injuries, insufficient imaging, or refused to participate. The ethical approval letter was provided by the hospital. Participation was completely optional, and patient data confidentiality and anonymity were scrupulously upheld. In order to collect data, eligible patients had both X-ray and CT PNS. Clinical and imaging data were obtained from Faisal Hospital in Lahore and documented on a standardized proforma. Imaging was performed in accordance with conventional sinus protocols, and radiologists assessed the results, recording findings such Lund-Mackay scores, sinus opacity, mucosal thickening, and hyperdense contents. The final diagnosis was verified by histological and endoscopic analysis. Before analysis, all data were classified and summarized via SPSS software version 26 to get results; the Chi-square test was utilized for inferential analysis and descriptive statistics were employed to summarize the distribution of the data. Tables and comparative charts were used to display the results for clinical interpretation.

RESULTS

Table 4.1

Age Distribution

Valid	Age Group (years)	Frequency	Percent	Valid Percent	Cumulative Percent
	12–20	3	5.00%	5.00%	5.00%
	21–30	7	11.70%	11.70%	16.70%
	31–40	18	30.00%	30.00%	46.70%
	41–50	17	28.30%	28.30%	75.00%
	51–60	11	18.30%	18.30%	93.30%
	61–70	4	6.70%	6.70%	100.00%

The age distribution shows that the majority of participants were middle-aged adults. The highest number of cases was observed in the 31–40 years age group (30.0%), followed closely by the 41–50 years group (28.3%). Together, these two age groups accounted for more than half of the study population, indicating that sinonasal diseases such as fungal sinusitis and nasal polyps are more prevalent in this age range. Only 5.0% of the patient seen in the age group of 12-20 years and 6.7% in the age group of 61-70 years. This indicates that the disease was rarely detected in adolescent and older people within this study.

Figure 4.1

shows graphical representation age distribution

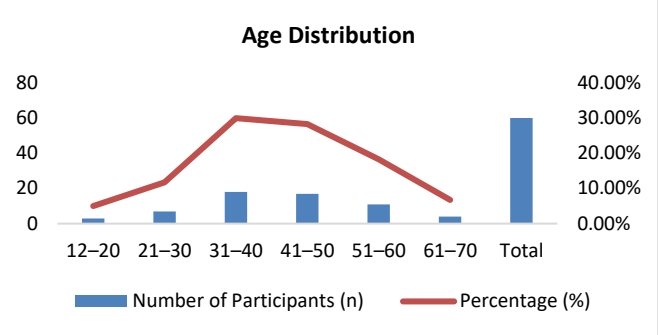

Table 4.2

Gender Distribution

Valid	Gender	Frequency	Percent	Valid Percent	Cumulative Percent
	Male	34	56.70%	56.70%	56.70%
	Female	26	43.30%	43.30%	100.00%
	Total	60	100.00%	100.00%	

In gender analysis, there were 34 males (56.7%) and 26 females (43.3%). Although both men and women were well represented, male predominance may be due to high exposure to environmental risk factors, work related hazards and lifestyle. However, the difference is not intense with suggest that both men and women were moderately influenced by sino-nasal patho-logies.

Figure 4.2

Shows graphical representation gender distribution

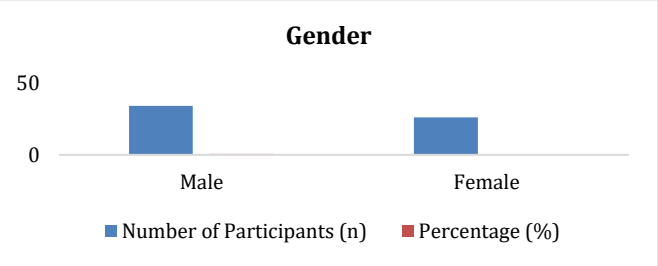

Table 4.3

Summary of the Demographics

Valid	Statistics	Value
	Age (years) (mean ± SD)	42.7 ± 12.4
	Age Range (min–max)	18–68
	Minimum Age	18
	Maximum Age	68

The demographic profile reveals the average age of 42.7± 12.4years, reaffirm that population primarily involved adults in the middle of age. The age group between 18-68 years widely represents adult patients. Gender dissemination remains balanced with male predominance. The result showed that the study sample is demographically appropriate for assessing imaging modalities in adult sino-nasal pathologies.

Table 4.4

Final Diagnosis of Participants

Valid	Diagnosis	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
	Fungal Sinusitis	28	46.70%	46.70%	46.70%
	Nasal Polyps	22	36.70%	36.70%	83.40%

Inconclusive	10	16.70%	16.70%	100.00%
Total	**60**	**100.00 %**	**100.00 %**	

46.7% patients were diagnosed from fungal sinusitis through clinical evaluation, imaging and histopathological findings. 36.7% cases were of nasal polyps while 16.7% cases remained inconclusive which may be due to overlapping features, initial stage and insufficient diagnostic markers.

Figure 4.3

Shows graphical representation final diagnosis of participants

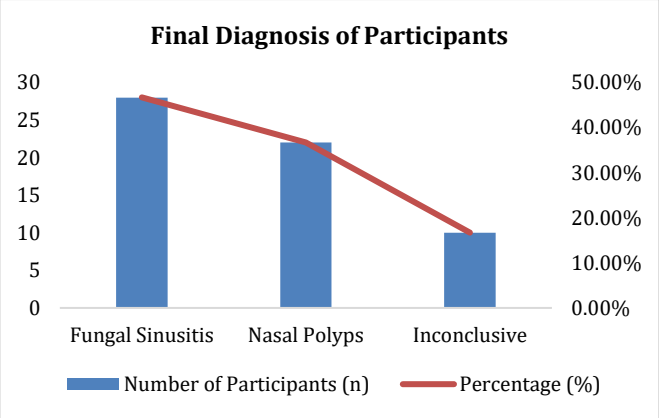

Table 4.5

Clinical Symptoms (from Data Collection Tool)

Symptom	Frequency (n)	Percentage (%)
Duration of symptoms (months), mean ± SD	10.2 ± 4.8	-
Nasal obstruction	52	86.70%
Rhinorrhea	39	65.00%
Facial pain/pressure	44	73.30%
Anosmia	22	36.70%
History of asthma or allergy	18	30.00%
Suspicion of fungal disease by ENT	55	91.70%
Endoscopy findings: Polyps	22	36.70%
Endoscopy findings: Fungal debris	28	46.70%
Endoscopy findings: Both (Polyps & Fungal debris)	6	10.00%
Endoscopy findings: None	4	6.70%
Histopathology results: Fungal sinusitis	28	46.70%
Histopathology results: Nasal polyps	22	36.70%
Histopathology results: Inconclusive	10	16.70%
Prior sinus surgery	0	0%

The average time of symptoms was 10.2 ± 4.8 months, mostly with chronic symptoms. The most common complaint by the patients was nasal obstruction (86.7%) then facial pressure and pain (73.3%), rhinorrhea (65%) and anosmia (36.7%). In (30.0%) of cases, there was history of asthma and allergy which indicates a relationship between allergic conditions and sino-nasal. Fungal disease is suspected in (91.7%) of patients by ENT specialists that indicates a strong suspicion of disease prior to imaging. Endoscopic findings were correlated with the final diagnosis. In (46.7%) cases fungal debris and in (36.7%) of cases nasal polyps were observed. Due to overlapping, a small proportion (10.0%) showed both findings. These findings were closely matched with histo-pathological findings. No patient had history of previous surgery of sinuses.

Figure 4.4

shows the clinical symptoms (from data collection tool)

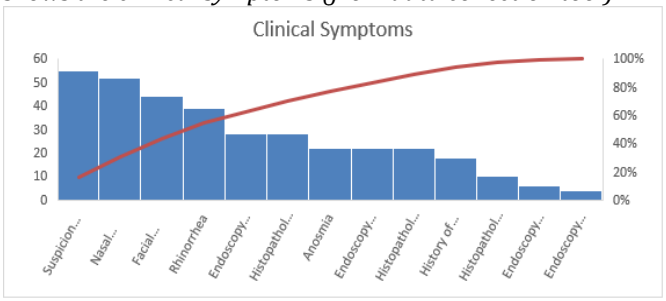

Table 4.6

Imaging Findings (X-ray vs CT)

X-ray/CT Finding	Fungal Sinusitis (n = 28)	Nasal Polyps (n = 22)
X-ray: Opacification with hyper density	18 (64.3%)	4 (18.2%)
X-ray: Sinus mucosal thickening	24 (85.7%)	20 (90.9%)
X-ray: Air-fluid level	10 (35.7%)	2 (9.1%)
X-ray: Bone erosion suspicion	6 (21.4%)	1 (4.5%)
CT: Heterogeneous opacity	26 (92.9%)	6 (27.3%)
CT: Hyper attenuation foci	22 (78.6%)	3 (13.6%)
CT: Bone thinning/erosion	14 (50.0%)	2 (9.1%)
CT: 'Double density sign'	18 (64.3%)	1 (4.5%)

In fungal sinusitis (85.7%) and nasal polyps (90.9%), the most common finding on X-ray modality was sinu mucosal thickening meaning that it is a non-specific feature. However, features in fungal sinusitis like opacification with hyper-density, air fluid levels and possible bone erosion were more commonly seen, indicates limited diagnosis. In comparative CT findings are revealed noticeable difference between these two diseases. In patient of fungal sinusitis hyper attenuating foci, heterogeneous opacity and DDS were mostly observed. Moreover, bone erosion and thinning was more common in fungal sinusitis than in nasal polyps. This manifest that CT is superior in detecting fungal sinusitis and also assess the extension of disease.

Table 4.7

Diagnostic Accuracy of X-ray vs CT scan (Sensitivity and Specificity)

Valid	Modality	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Accuracy
	X-ray	64.3% (50.6–77.1)	70.8% (57.5–81.9)	69.20%	66.70%	67.50 %
	CT scan	92.9% (83.6–97.6)	90.9% (79.3–97.1)	92.90%	90.90%	91.70 %

Sensitivity (64.3%) and specificity (70.8%) with an overall diagnostic accuracy of (67.5%) is revealed by X-ray and the difference was not statistically considerable (p = 0.32). This indicates that X-ray can fail to detect the significant number of cases and give rise to false positive results. However, CT scan was (92.9%) sensitive and (90.9%) specific with accuracy of 91.7% The results were statistically significant (p< 0.001) which confirms that CT is highly reliable imaging modality in differentiating fungal

sinusitis from nasal polyps. High PPV and NPV further support its diagnostic superiority.

Table 4.8

Chi-Square Cross-Tabulation of X-ray vs CT Accuracy

Modality	P-value
X-ray	p = 0.32
CT scan	p < 0.001

A remarkable correlation between CT confirmed diagnoses and X-ray findings were confirmed by Chi-square analysis (x2 = 12.7, p< 0.001). X-ray can identify some fungal cases but some features can be missed or misclassified. This statistical result reinforces the limited reliability of X-ray when compared with CT-image.

Cross-Tabulation of X-ray vs CT Accuracy

	Diagnosis by X-ray	True Fungal (CT Confirmed)	True Polyp/Other	Total
Valid	Positive (suggestive of fungal)	18	8	26
	Negative/Indeterminate	10	24	34

Chi-square test: χ^2 =	12.7
P Value =	p < 0.001

Table 4.9

Adverse Events Reported During Imaging

	Adverse Event	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Valid	No adverse event	55	91.70%	91.70%	91.70%
	Minor discomfort during CT	5	8.30%	8.30%	100.00%

Imaging procedures were generally safe and well tolerated. The majority of patients (91.7%) experienced no adverse events. Minor discomfort during CT scanning was reported in 8.3% of participants, which did not require medical intervention. No serious complications were observed, supporting the safety of CT imaging despite its higher radiation exposure.

DISCUSSION

The findings of this study manifest that CT scan is markedly more sensitive than the plain Radiograph in diagnosing the disease. CT scan provides the better visualization of opacification in sinuses, bone erosion and hyper-densities in case of fungal elements. In the present study x-ray of PNS detects opacification of sinuses and mucosal thickening in some cases. Although it fails to accurately determine the bone erosion, hyper-densities and extend of disease. This is because of two dimensional natures of radiography and its overlapping structures. While CT clearly determines the extend of disease. They evaluate lesions of paranasal sinuses by comparing CT and computed radiography (CR). Both X-rays and CT scans were performed on patients with a clinical suspicion of sinus disease, and the kind, location, and size of lesions seen in the imaging results were examined. The ethmoid, frontal, and sphenoid sinuses could not be adequately assessed by plain X-rays, although they could detect gross anomalies including air-fluid levels and maxillary sinus opacification. In addition to accurately identifying anatomical changes pertinent to surgery, CT showed greater delineation of mucosal illness, polyps, bony walls, and extra sinus extension. Numerous lesions that were deemed minimal on X-rays were shown to be more extensive on CT, according to the study. While CT is the preferred test for accurate diagnosis, staging, and surgical planning of paranasal sinus lesions, X-rays are cheap and helpful for preliminary screening [23]. Previous study assessed computed tomography (CT) and plain-film radiography, for the assessment of the paranasal sinus. Due to overlapping features, plain X-rays offer poor sensitivity for the ethmoid, frontal, and sphenoid sinuses, although they are helpful for the initial screening of gross maxillary sinus illness. CT is regarded as the gold standard because it provides a thorough evaluation of sinus anatomy, mucosal disease, bony structures, and complications. It is also crucial for surgical planning, especially in cases of sinonasal tumor, fungal infection, and chronic sinusitis. It does this by better characterizing soft-tissue lesions, distinguishing between fungal debris, polyps, and neoplasms, and identifying intracranial or orbital extension. In order to maximize diagnosis and treatment, the authors stress the significance of choosing the right imaging modality based on clinical presentation, disease severity, and surgical procedures [24]. This study evaluates the CT results in patients with the suspicion of invasive fungal sinusitis that had been confirmed by histopathology. The study evaluates CT images for extra sinus extension, bony alterations and involvement of sinuses. Common observations were including unilateral sinus opacifications, soft tissue density within the sinuses and early infiltration of nearby fat planes. Many early cases showed no sign of bone erosion, demonstrating that invasive disease might develop without evident bone loss. They concluded that CT is crucial for the early identification of invasive fungal sinusitis but prompt treatment requires close attention to soft tissue alterations [25].

CONCLUSION

This study highlights the role of radiological imaging in assessing sinonasal conditions particularly fungal sinusitis and nasal polyps. Plain X-ray of PNS only detects basic inflammatory changes with low sensitivity and specificity however overlapping structures limits the diagnostic accuracy. Although X-ray may still use as an initial screening tool in the resource limited settings. On the other hand, CT offers high sensitivity, specificity and overall diagnostic accuracy. It detects characteristic features like hyper-attenuating foci, sinus opacities, bony degeneration and DDS which strongly corresponds with endoscopic and histopathological findings. CT should be preferred whenever available for definitive diagnosis because it offers more accurate and comprehensive assessment of sino-nasal pathology and also assist in surgical planning.

Limitations

The single center approach and small sample size may restrict how far the results can be applied. Moreover, some cases remained inconclusive despite imaging and histopathology, suggesting that early disease or overlapping features may still oppose diagnostic challenges. Finally, long term follow-up of patients was not performed, which limited assessment of disease progression and treatment.

Recommendations

Computed Tomography should be routinely used as the primary imaging modality in patients with suspected fungal sinusitis or nasal polyps due to its high diagnostic accuracy and ability to assess disease extent. Plain X-ray may be used as an initial screening tool in peripheral or resource-limited healthcare settings; however, confirmatory CT imaging is strongly advised in suspicious or unresolved cases. By collaborating radiologist, pathologist and ENT specialist improves the diagnostic accuracy and health status. Additionally, a long period imaging and check-in should be integrated to analyze; how well treatment works, identifying any re-occurring the disease and its overall prognosis.

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