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Diagnostic Value of High-Resolution CT in the Assessment of Paranasal Sinus Pathologies

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ABSTRACT

Background: Paranasal sinus diseases are common disorders that can significantly affect a patient's quality of life and daily functioning. Accurate imaging plays an important role in identifying the extent of disease, guiding treatment decisions, and preventing complications. High-resolution computed tomography (HRCT) is considered the preferred imaging technique for evaluating sinonasal diseases because it provides excellent visualization of both bony structures and soft tissues. **Objective:** This study aimed to determine the diagnostic value of HRCT in assessing paranasal sinus pathologies and to evaluate associated anatomical variations using the Lund–Mackay scoring system. **Methodology:** A descriptive cross-sectional study was conducted on 40 patients presenting with symptoms suggestive of sinonasal disease. HRCT scans of the paranasal sinuses were performed and assessed for sinus involvement, type of pathology, anatomical variations, and radiological severity. **Results:** The mean age of the participants was 40.45 ± 15.99 years, and males represented 60% of the study population. Acute sinusitis was the most frequently observed pathology (35%), followed by mucocele (30%), chronic sinusitis (20%), and fungal sinusitis (15%). The maxillary sinus was the most commonly affected sinus. Common presenting symptoms included facial pain, nasal discharge, headache, and hyposmia. Anatomical variations such as Onodi cells, Concha bullosa, and Haller cells were frequently identified on HRCT scans. The mean Lund–Mackay score was 5.50 ± 2.55, indicating moderate radiological disease severity. Statistical analysis showed no significant association between gender and pathology type, anatomical variations, or Lund–Mackay score ($p > 0.05$). **Conclusion:** The findings of this study demonstrate that HRCT is a highly reliable and effective imaging modality for evaluating paranasal sinus diseases. It provides detailed information regarding disease extent, sinus involvement, and anatomical variations, which are essential for accurate diagnosis and surgical planning.

INTRODUCTION

Paranasal sinus diseases are among the most frequently encountered conditions in otolaryngology practice and represent a major cause of morbidity worldwide. These conditions commonly present with symptoms such as nasal obstruction, facial pain, headache, postnasal drip, nasal discharge, and hyposmia [4,8]. The paranasal sinuses, including the frontal, maxillary, ethmoid, and sphenoid sinuses, are air-filled cavities that contribute to humidification of inspired air, enhancement of voice resonance, and reduction of skull weight. Pathological involvement of these sinuses may result from inflammatory, infectious, allergic, fungal, or obstructive etiologies [2,4].

Conventional radiography was historically used in the evaluation of sinus diseases; however, it provides limited visualization of complex sinonasal anatomy and subtle mucosal pathology. High-resolution computed tomography (HRCT) has become the gold standard imaging modality for sinonasal assessment due to its superior spatial resolution and ability to delineate both bone and soft tissue structures accurately [1,2]. HRCT plays a crucial role in identifying mucosal thickening, sinus opacification, bony erosions, air-fluid levels, and anatomical variations that may predispose to disease or complicate surgery [5,6].

Globally, chronic rhinosinusitis affects approximately 10–15% of the population, significantly impacting quality of life and healthcare resources [4]. Environmental pollution, smoking, allergic rhinitis, and recurrent upper respiratory tract infections contribute substantially to disease burden, especially in developing countries such as Pakistan [8,10].

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The pathophysiology of sinus disease is multifactorial and includes obstruction of sinus ostia, impaired mucociliary clearance, mucosal edema, and bacterial or fungal infection [3]. Anatomical variations such as Concha bullosa, Haller cells, Agger nasi cells, deviated nasal septum, and Onodi cells may obstruct sinus drainage pathways and increase susceptibility to chronic inflammation [1,9].

HRCT is particularly valuable in preoperative evaluation for functional endoscopic sinus surgery (FESS), where precise anatomical mapping is essential to avoid complications involving adjacent structures such as the orbit and skull base [3,6]. Despite widespread international use, limited local data exist regarding the diagnostic utility of HRCT in Pakistani patients, which justifies the need for this study [8].

METHODOLOGY

A descriptive cross-sectional study was conducted at Omar Hospital and Cardiac Center Johar Town, Lahore for the duration of 4 months January 2026 to April 2026 on 40 patients presenting with sinonasal symptoms at a tertiary care hospital. Patients aged 12 years and above with complaints suggestive of paranasal sinus disease, including facial pain, nasal obstruction, nasal discharge, postnasal drip, headache, and hyposmia were included [4,8]. Patients with facial trauma, previous sinonasal surgery, or contraindications to CT imaging were excluded.

HRCT scans of the paranasal sinuses were performed using a multidetector CT scanner. Thin-section axial and coronal images were obtained for detailed evaluation of sinonasal structures. Scans were assessed for mucosal thickening, sinus opacification, air-fluid levels, bony erosions, and anatomical variations including Concha bullosa, Haller cells, Onodi cells, Agger nasi cells, and deviated nasal septum [1,5].

The Lund–Mackay scoring system was used to assess radiological severity of disease [2]. Data were analyzed using SPSS version 26. Descriptive statistics were applied for demographic variables, while chi-square tests were used to determine associations between variables. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 40 patients were included in the study. The mean age was 40.45 ± 15.99 years, consistent with previous studies reporting adult predominance in sinonasal disease [5,10]. Males constituted 60% of cases, similar to findings reported by Wani et al. [5].

The most common symptoms included hyposmia, facial pain, nasal discharge, headache, and postnasal drip, which aligns with findings described by Bhattacharyya [4], who noted that sinonasal diseases often present with nonspecific overlapping symptoms.

Maxillary sinus involvement was the most frequent radiological finding, followed by sphenoid, ethmoid, and frontal sinuses. This pattern is consistent with previous studies by Ahmad et al. and Wani et al. [5,8], who also identified the maxillary sinus as the most commonly affected sinus.

Acute sinusitis was the most common pathology (35%), followed by mucocele (30%), chronic sinusitis (20%), and fungal sinusitis (15%), which is comparable to findings reported in similar regional studies [8,10].

Anatomical variations were frequently observed, with Onodi cells being the most common variation, followed by Concha bullosa and Haller cells. These findings are consistent with Bolger et al. [1] and Kandemir et al. [9], who emphasized the clinical importance of such variations in sinus disease and surgery.

The mean Lund–Mackay score was 5.50 ± 2.55, indicating moderate disease severity and supporting the validity of this scoring system in radiological assessment [2]. No significant association was observed between gender and disease severity, pathology type, or anatomical variations ($p > 0.05$), which is consistent with previous studies [4,10].

Table 1

Demographic, Clinical, and Radiological Characteristics of Patients with Paranasal Sinus Pathologies (N=40)

Variable	Category	Frequency (%) / Mean ± SD
Age (years)	Mean ± SD	40.45 ± 15.99
	Range	15–65
Gender	Male	24 (60%)
	Female	16 (40%)
Duration of Symptoms (months)	Mean ± SD	12.00 ± 7.22
	Range	1–24
Main Complaints	Hyposmia	6 (15%)
	Facial Pain + Postnasal Drip	4 (10%)
	Headache	4 (10%)
	Nasal Discharge	4 (10%)
	Facial Pain + Headache	3 (7.5%)
	Facial Pain + Hyposmia	3 (7.5%)
	Facial Pain + Nasal Discharge	3 (7.5%)
	Hyposmia + Nasal Discharge	3 (7.5%)
	Nasal Obstruction	3 (7.5%)
	Others	7 (17.5%)
Sinus Involved	Maxillary + Ethmoid + Frontal	4 (10%)
	Maxillary + Sphenoid	4 (10%)
	Maxillary + Sphenoid + Ethmoid	4 (10%)
	Sphenoid	4 (10%)
	Frontal	4 (10%)
	Others	20 (50%)
Type of Pathology	Acute Sinusitis	14 (35%)
	Mucocele	12 (30%)
	Chronic Sinusitis	8 (20%)
	Fungal Sinusitis	6 (15%)
Anatomical Variations	Onodi Cell	7 (17.5%)
	Concha Bullosa	5 (12.5%)
	Haller Cell	5 (12.5%)
	None	4 (10%)

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	Others / Combined Variations	19 (47.5%)
Lund–Mackay Score (Right)	Mean ± SD	3.10 ± 1.93
Lund–Mackay Score (Left)	Mean ± SD	2.40 ± 1.89
Lund–Mackay Score (Total)	Mean ± SD	5.50 ± 2.55
	Range	0–10

Table 2

Association of Clinical and Radiological Variables in Patients with Paranasal Sinus Pathologies

Variables Compared	Statistical Test	p-value	Interpretation
Gender vs Lund–Mackay Total Score	Pearson Chi-Square	0.265	Not Significant
Gender vs Anatomical Variations	Pearson Chi-Square	0.833	Not Significant
Gender vs Type of Pathology	Pearson Chi-Square	0.366	Not Significant
Type of Pathology vs Main Complaints	Pearson Chi-Square	0.735	Not Significant
Type of Pathology vs Sinus Involved	Pearson Chi-Square	0.421	Not Significant
Type of Pathology vs Anatomical Variations	Pearson Chi-Square	0.522	Not Significant

DISCUSSION

The present study confirms the diagnostic value of HRCT in evaluating paranasal sinus diseases. HRCT provides detailed anatomical and pathological information, making it essential for both diagnosis and surgical planning [1,2].

The demographic pattern observed in this study is consistent with findings of Wani et al. [5] and Ali et al. [10], who reported higher prevalence in adult males. Clinical symptoms such as facial pain, nasal obstruction, and hyposmia were common, similar to findings by Bhattacharyya [4], who highlighted the nonspecific nature of sinonasal disease presentation.

Maxillary sinus predominance observed in this study aligns with previous research [5,8], likely due to its anatomical drainage pathway and susceptibility to infection. Multi-sinus involvement further reflects the chronic inflammatory nature of sinonasal disease [3].

The Lund–Mackay scoring system proved useful in assessing disease severity, consistent with Lund and Kennedy's original work [2]. The moderate scores observed indicate significant but variable disease burden among patients.

Anatomical variations such as Concha bullosa, Haller cells, and Onodi cells were frequently detected, consistent with Bolger et al. [1]. These variations are clinically important as they may obstruct sinus drainage pathways and increase the risk of complications during functional endoscopic sinus surgery [6,9].

The lack of significant associations between anatomical variations and disease severity suggests that while such variations may contribute to disease development, they are not sole causative factors [9,10]. Overall, HRCT remains the imaging modality of choice for comprehensive evaluation of sinonasal disease due to its accuracy, reproducibility, and surgical relevance [1,6].

CONCLUSION

HRCT is a highly effective imaging modality for evaluating paranasal sinus pathologies. It provides precise information on sinus involvement, disease severity, and anatomical variations essential for diagnosis and surgical planning. The Lund–Mackay scoring system remains a reliable tool for assessing radiological severity. HRCT is therefore indispensable in the comprehensive evaluation and management of sinonasal disease.

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