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Radiographic evaluation of maxillary sinusitis pathologies through cone-beam computed tomography: A cross-sectional study

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Abstract:
Odontogenic maxillary sinusitis is frequently underdiagnosed because conventional clinical and radiographic examinations may not accurately identify its dental origin. Therefore, it is of interest to evaluate the diagnostic value of cone-beam computed tomography in 96 patients with clinically suspected maxillary sinusitis. CBCT identified odontogenic causes in 60% of cases, with mucosal thickening and periapical pathology being the most frequent radiographic findings. Unilateral sinus involvement was significantly associated with odontogenic sinusitis, demonstrating the diagnostic advantage of CBCT over conventional assessment. Thus, data shows the routine use of CBCT for accurate diagnosis, severity assessment and treatment planning in patients with suspected odontogenic maxillary sinusitis.

Keywords: Cone-beam computed tomography (CBCT); maxillary sinusitis; odontogenic sinusitis; mucosal thickening; oral radiology

Background:
The posterior maxillary premolars and molars are particularly vulnerable to dental influences because their roots are often in close proximity to, or may even project into, the maxillary sinus floor. This anatomical relationship facilitates the spread of pulpal, periapical, periodontal and iatrogenic infections into the sinus, resulting in odontogenic maxillary sinusitis, a condition that is frequently underdiagnosed in routine clinical practice **[1–3]**. Earlier reports suggested that odontogenic causes accounted for only a small proportion of maxillary sinusitis; however, more recent evidence has demonstrated a substantially higher prevalence, particularly in cases of unilateral maxillary sinus disease **[4–6]**. The introduction of cone-beam computed tomography (CBCT) has significantly improved diagnostic accuracy by enabling simultaneous three-dimensional evaluation of the sinus mucosa, sinus floor, root apices and surrounding alveolar bone, thereby overcoming the limitations of conventional two-dimensional radiography **[7, 8]**. Compared with panoramic and paranasal sinus radiographs, CBCT provides superior visualization of mucosal thickening, periapical lesions, periodontal bone loss, oroantral communications and foreign bodies associated with the maxillary sinus **[8, 9]**. Previous CBCT-based studies have consistently demonstrated significant associations between maxillary sinus mucosal thickening and adjacent odontogenic pathology, including apical periodontitis and periodontal bone loss, supporting the role of dental disease in the development of sinus pathology **[10–12]**. Therefore, it is of interest to describe the odontogenic causes, radiographic characteristics and severity patterns of maxillary sinusitis using cone-beam computed tomography.

Materials and Methods:
This is a cross sectional observational study which was performed in the Department of Oral Medicine and Radiology, NIMS Dental College & Hospital, Jaipur after obtaining approval from the Institutional Ethics Committee (IEC/P-555/2024). The study framework was designed based on the uploaded dissertation protocol. A total of 96 patients with clinically suspected maxillary sinusitis were included. The sample size was calculated based on the prevalence formula and rounded to 96. Patients were included if they had symptoms of maxillary sinusitis, unilateral or bilateral and complete CBCT scans of the maxillary sinus region. Patients were excluded if they had a history of maxillofacial trauma, congenital craniofacial defects, clefts, or granulomatous disease. Clinical evaluation comprised of history of facial pain or pressure, facial fullness, nasal obstruction, postnasal discharge, hyposmia, fever, headache, halitosis, malaise, dental pain, cough and otalgia. There were no routine laboratory investigations, as diagnosis was largely clinical and radiographic. CBCT scans were acquired using a standard protocol of 60-120 kV, 5-12 mA, 10-14 s exposure time and 8 × 10 cm FOV. Axial, coronal and sagittal images were assessed with Ez3D-i software. The following variables were recorded: age, sex, laterality, mucosal thickening, polypoidal changes, partial opacification, complete opacification, periapical pathology, periodontal bone loss, sinus floor discontinuity, oroantral communication and presence of displaced dental materials or other iatrogenic factors. The diagnosis of odontogenic maxillary sinusitis was made when the radiographic sinus changes were associated with an identifiable dental source including periapical radiolucency that was similar in size to the sinus, periodontal destruction adjacent to the sinus, localized mucosal thickening over a diseased tooth, or disruption of the sinus floor that corresponded to dental pathology. Severity was graded as follows: mild, when the mucosal thickening was limited to the sinus floor; moderate, when there was partial sinus opacification or polypoidal mucosal change; severe, when there was near complete or complete sinus opacification with or without associated bony change. The data were entered into SPSS version 27. The data for continuous variables were expressed as mean ± standard deviation, while the categorical variables were expressed as number and percentage. Categorical comparisons were made using a chi-square test, continuous variables across severity groups were made using one-way ANOVA and the relationship between odontogenic factors and severity were evaluated using a Spearman correlation. A p value of <0.05 was deemed to be statistically significant.

Results:

The study included 96 patients with a mean age of 36.8 ± 11.4 years (range: 18-64 years). Females constituted 52.1% of the sample. Odontogenic etiology was detected in 60.4% of cases. Overall, unilateral sinus involvement was more frequent than bilateral disease, particularly among odontogenic cases. Female patients slightly outnumbered male patients, but the difference was not statistically significant (p = 0.680). Odontogenic sinusitis was significantly associated with unilateral disease when compared with non-odontogenic sinusitis (72.4% vs 36.8%, p = 0.002). Mucosal thickening was the dominant radiographic finding and was significantly more common in the odontogenic group. Periapical pathology was the leading odontogenic source, followed by periodontal bone loss. A small subset had iatrogenic involvement, including oroantral communication or foreign material proximity to the sinus floor. Mild disease was the most frequent severity category, followed by moderate and severe disease. Mean age tended to increase with severity, although this trend did not reach statistical significance on ANOVA (p = 0.071). Mean mucosal thickness increased significantly across severity categories (p < 0.001). Spearman analysis showed a modest positive correlation between the burden of odontogenic pathology and severity score (r = 0.34, p = 0.001) **(Table 1-3).**

Table 1: Baseline demographic and etiologic distribution

Variable	n (%) or mean ± SD
Age (years)	36.8 ± 11.4
Male	46 (47.9)
Female	50 (52.1)
Odontogenic sinusitis	58 (60.4)
Non-odontogenic sinusitis	38 (39.6)
Unilateral involvement	56 (58.3)
Bilateral involvement	40 (41.7)

Table 2: CBCT findings according to etiology

CBCT finding	Odontogenic (n=58)	Non-odontogenic (n=38)	Total (n=96)	p value
Mucosal thickening	34 (58.6)	11 (28.9)	45 (46.9)	0.004
Partial opacification	11 (19.0)	12 (31.6)	23 (24.0)	0.161
Polypoidal change / retention cyst	8 (13.8)	9 (23.7)	17 (17.7)	0.216
Complete opacification	5 (8.6)	6 (15.8)	11 (11.5)	0.289
Periapical pathology	38 (65.5)	0	38 (39.6)	<0.001
Periodontal bone loss	24 (41.4)	0	24 (25.0)	<0.001
Iatrogenic factor / OAC	7 (12.1)	0	7 (7.3)	0.019

Table 3: Severity distribution and associated variables

Severity	n (%)	Mean age (years)	Odontogenic cases n (%)	Mean mucosal thickness (mm)
Mild	40 (41.7)	34.2 ± 10.7	26 (65.0)	3.1 ± 0.9
Moderate	34 (35.4)	37.4 ± 11.2	21 (61.8)	6.2 ± 1.4
Severe	22 (22.9)	41.3 ± 11.8	11 (50.0)	10.8 ± 2.6

Discussion:

The present study demonstrated that odontogenic pathology was the predominant cause of maxillary sinusitis, supporting recent evidence that dental disease contributes substantially to unilateral maxillary sinus involvement and is more prevalent than previously recognized **[1–3]**. These findings reinforce the importance of incorporating routine dental assessment into the diagnostic work-up of patients presenting with persistent or recurrent maxillary sinus disease. Mucosal thickening was the most frequent CBCT finding observed in the present study. Similar observations have been reported by Whyte & Boeddinghaus and Maillet *et al.* who demonstrated that maxillary sinus mucosal thickening is strongly associated with adjacent periapical inflammatory lesions and represents one of the earliest radiographic manifestations of odontogenic sinus disease **[4, 5]**. Periapical lesions and periodontal bone loss were the principal odontogenic sources identified in the present investigation. These findings agree with previous CBCT studies showing that the severity of periodontal destruction, proximity of periapical lesions to the sinus floor and lesion size significantly increase the likelihood of sinus mucosal alterations **[6–8]**. Another important observation was that most odontogenic cases exhibited unilateral sinus involvement. This characteristic has consistently been regarded as an important diagnostic indicator distinguishing odontogenic sinusitis from rhinogenic disease and should prompt careful evaluation of adjacent teeth, previous dental treatment and periodontal status during radiographic interpretation **[9]**. No significant association between gender and odontogenic sinusitis was observed in the present study. Similar findings have been reported in previous investigations, suggesting that local dental pathology has a greater influence on disease occurrence than demographic characteristics **[8, 10]**. The present findings further highlight the diagnostic superiority of CBCT over conventional two-dimensional imaging. Three-dimensional visualization enables accurate assessment of mucosal thickening, periapical lesions, periodontal bone loss, sinus floor defects and other odontogenic factors that may remain undetected on panoramic radiographs, thereby improving diagnostic confidence and facilitating interdisciplinary management **[11]**. Most cases in the present study demonstrated mild-to-moderate disease severity, suggesting that CBCT can identify odontogenic sinus pathology before complete sinus opacification develops. Early recognition of these radiographic changes may facilitate timely endodontic, periodontal, or surgical intervention and reduce the risk of persistent or recurrent sinus disease **[12]**. Cone-beam computed tomography provides detailed three-dimensional assessment of the maxillary sinus and improves identification of odontogenic causes that may be obscured on conventional two-dimensional imaging **[13]**. The present study has certain limitations. Its cross-sectional design precludes assessment of temporal causality, while microbiological findings and treatment outcomes were not evaluated. Furthermore, although the sample size was adequate for descriptive analysis, larger multicenter prospective studies

are needed to validate these findings and further define the relationship between specific odontogenic lesions and maxillary sinus disease.

Conclusion:

We show the odontogenic pathology was the predominant cause of maxillary sinusitis, with mucosal thickening being the most frequent CBCT finding. Periapical pathology was the principal odontogenic source and unilateral sinus involvement strongly suggested a dental origin. Thus, CBCT provides valuable diagnostic information and supports early dental evaluation for accurate management of suspected odontogenic maxillary sinusitis.

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