



A Study To Assess The Maxillary Sinus Pathologies in Digital Panoramic Radiography- A Cross Sectional Study

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Abstract

Background: This study underscores the diagnostic value of digital panoramic radiographs as an effective preliminary tool for detecting maxillary sinus pathologies.

Material and Methods: Among the 500 radiographs analyzed, common findings included mucosal thickening, sinus opacification, air-fluid levels, retention cysts, polypoid lesions, and maxillary sinusitis.

Results: A strong correlation was observed between panoramic findings and CBCT confirmation, with CBCT verifying over 90% of cases across all pathology types. Despite this correlation, CBCT demonstrated superior visualization and diagnostic clarity, especially for complex or overlapping anatomical structures.

Conclusion: These findings emphasize the importance of using CBCT for definitive diagnosis, particularly in cases where treatment planning depends on detailed

anatomical assessment. Clinicians should recognize both the strengths and limitations of panoramic imaging and incorporate CBCT when higher diagnostic accuracy is essential.

Keywords: Maxillary sinus, panoramic radiography, CBCT, sinus pathology, mucosal thickening, sinus opacification.

Introduction

The maxillary sinus, one of the paired paranasal sinuses, contributes significantly to various physiological functions such as reducing skull weight, humidifying and filtering inhaled air, and enhancing speech resonance. Anatomically located above the upper premolars and molars, it is closely associated with the nasal cavity, orbit, and other facial structures, making it vulnerable to a range of pathologies including sinusitis, mucosal thickening, cysts, polyps, and tumors. These conditions may arise due to infections, anatomical variations, dental procedures, or upper respiratory issues, and can impact adjacent structures, particularly the maxillary teeth and upper airway.

Among the most common conditions is sinusitis, which may be acute (often infectious) or chronic (linked to allergies or structural blockages). Other abnormalities such as polyps and cysts may be asymptomatic initially but can later manifest as facial pain, dental discomfort, nasal congestion, or more severe complications if left untreated.

Radiographic imaging plays a vital role in the early detection and diagnosis of maxillary sinus pathologies. While CT and conventional radiographs have been widely used, digital panoramic radiography has emerged as a preferred tool due to its broad field of view, lower radiation dose, and integration into routine dental assessments. Despite its lower resolution compared to

CT, panoramic radiography effectively identifies common sinus conditions such as mucosal thickening, air-fluid levels, and cystic lesions, serving as a valuable screening tool in dental practice.^[1-20]

Aims and Objectives

This study aimed to evaluate the prevalence and radiographic appearances of maxillary sinus pathologies on digital panoramic radiographs. It also assessed the diagnostic efficacy of panoramic imaging, along with variations in pathology and morphology between the right and left maxillary sinuses.

Materials & Methods

This cross-sectional study utilized 500 digital panoramic radiographs sourced from the Radiology section of the Department of Oral Medicine and Radiology at Darshan Dental College and Hospital, Udaipur. The radiographs, part of routine dental evaluations, were selected based on inclusion criteria: patients aged 18 years or older, with clearly visible right and left maxillary sinuses. Radiographs with positioning errors or obscured sinuses were excluded.

Materials Used

Panoramic images were obtained using the *X-mind PANO D Plus* digital system (Photograph 1), ensuring consistent image quality. Analysis was performed using DIGORA-compatible imaging software (Version DFW 2.8), which allowed for image enhancement, precise measurements, and consistent evaluation.



Figure 1: X mind PANO D Plus

Radiograph Acquisition and Evaluation

All radiographs were acquired under standard exposure parameters and reviewed under controlled lighting conditions on a 22-inch CRT monitor. Image adjustments such as zoom, brightness, and contrast were applied as necessary. Evaluation focused on the mediolateral and superioinferior dimensions, and assessment of the floor, roof, and sinus walls for pathological changes. A magnification factor correction was applied to avoid distortion.

Pathology Classification and Scoring

Maxillary sinus conditions were classified using the Nunes et al. system into categories: normal, mucosal thickening, sinus polyp, antral pseudocyst, nonspecific opacification, periostitis, antrolith, and antrolith with mucosal thickening. (Photograph 2 & 3) Each condition was rated using a 5-point scale:

- 1 – Definitely absent
- 2 – Probably absent
- 3 – Uncertain
- 4 – Probably present
- 5 – Definitely present

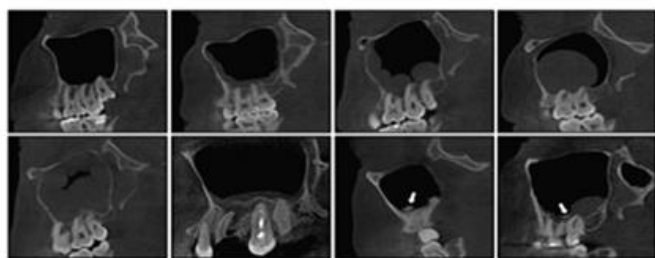


Figure 2: Sagittal sections of cone-beam computed tomography show examples of maxillary sinus abnormalities. A. Normal. B. Mucosal thickening. Sinus polyp. D. Antral pseudocyst. E. Non-specific opacification. F. Periostitis. G. Antrolith. H. Antrolith associated with mucosal thickening. The arrows indicate an antrolith inside the maxillary sinus.

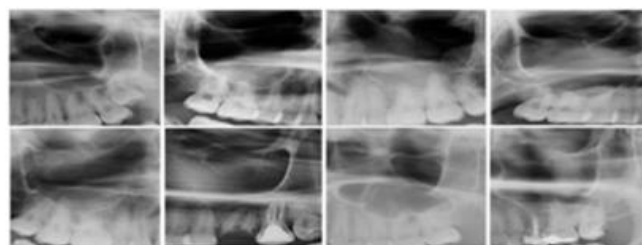


Figure 3: Sections of cropped panoramic radiographs show examples of maxillary sinus abnormalities. A. Normal. B. Mucosal thickening. C. Sinus polyp. D. Antral pseudocyst. E. Non-specific opacification. F. Periostitis. G. Antrolith. H.

Observer Reliability

To ensure intra-observer reliability, 20% of the radiographs were re-evaluated after 30 days, and consistency of observations was statistically assessed.

Statistical Analysis

Data were recorded in Microsoft Excel and analyzed using descriptive statistics (mean and standard deviation) for continuous variables. Chi-square tests assessed categorical data, while ANOVA determined group differences based on sinus pathology classification. A p-value <0.05 was considered statistically significant.^[20-40]

Schematic Diagram of Methodology

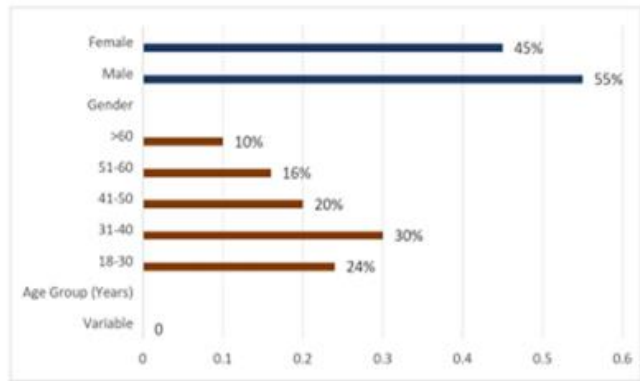


Results

This cross-sectional study analyzed 500 digital panoramic radiographs to evaluate the prevalence and characteristics of maxillary sinus pathologies. The study population included 275 males (55%) and 225 females (45%), with the highest representation in the 31–40 age group (30%). (Table and graph 1)

Variable	Frequency (n)	Percentage (%)
Age Group (Years)		
18-30	120	24%
31-40	150	30%
41-50	100	20%
51-60	80	16%
>60	50	10%
Gender		
Male	275	55%
Female	225	45%

Table 1:

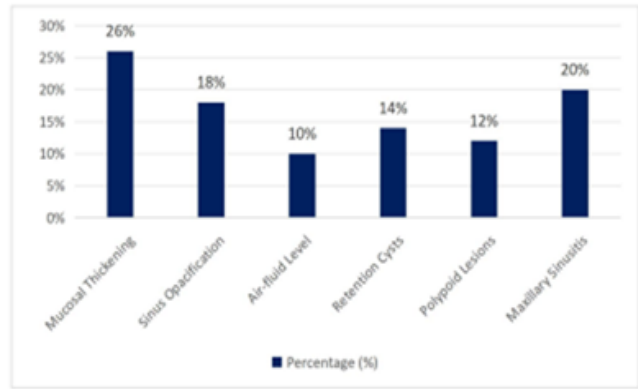


Graph 1:

Prevalence and Types of Pathologies: Mucosal thickening was the most common pathology, seen in 26% of cases, followed by maxillary sinusitis (20%), sinus opacification (18%), retention cysts (14%), polypoid lesions (12%), and air-fluid levels (10%). (Table and graph 2)

Pathology Type	Number of Cases (n)	Percentage (%)
Mucosal Thickening	130	26%
Sinus Opacification	90	18%
Air-fluid Level	50	10%
Retention Cysts	70	14%
Polypoid Lesions	60	12%
Maxillary Sinusitis	100	20%

Table 2:

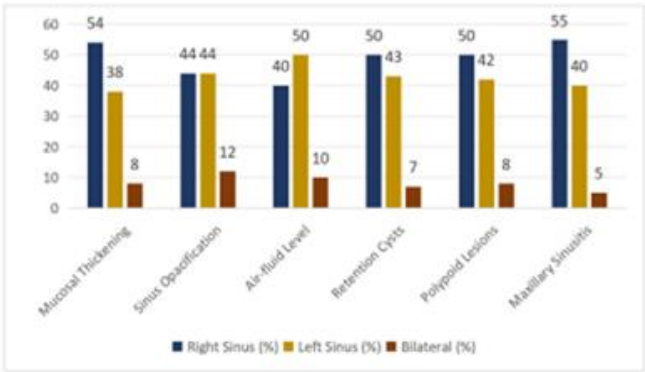


Graph 2:

Laterality and Morphological Variations: Most pathologies were unilateral, with a higher occurrence on the right side, particularly for mucosal thickening (54%) and sinusitis (55%). Morphological variations such as hypoplasia (8% right, 7% left), hyperplasia (6% right, 5% left), and septa (12% right, 11% left) revealed structural asymmetry between the sinuses. (Table and graph 3, 4 & 5).

Pathology Type	Right Sinus (n, %)	Left Sinus (n, %)	Bilateral (n, %)
Mucosal Thickening	70 (54%)	50 (38%)	10 (8%)
Sinus Opacification	40 (44%)	40 (44%)	10 (12%)
Air-fluid Level	20 (40%)	25 (50%)	5 (10%)
Retention Cysts	35 (50%)	30 (43%)	5 (7%)
Polypoid Lesions	30 (50%)	25 (42%)	5 (8%)
Maxillary Sinusitis	55 (55%)	40 (40%)	5 (5%)

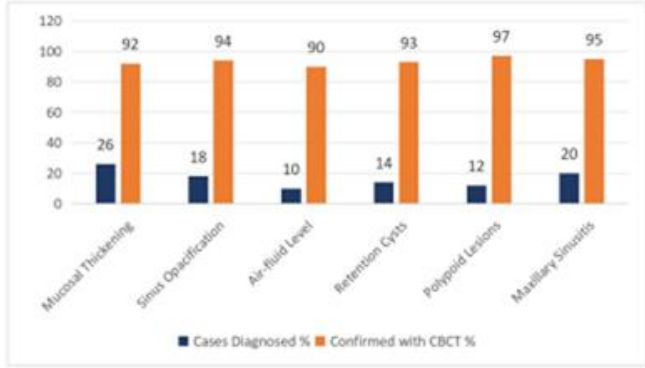
Table 3:



Graph 3:

Parameter	Cases Diagnosed (n, %)	Confirmed with CBCT (n, %)
Mucosal Thickening	130 (26%)	120 (92%)
Sinus Opacification	90 (18%)	85 (94%)
Air-fluid Level	50 (10%)	45 (90%)
Retention Cysts	70 (14%)	65 (93%)
Polypoid Lesions	60 (12%)	58 (97%)
Maxillary Sinusitis	100 (20%)	95 (95%)

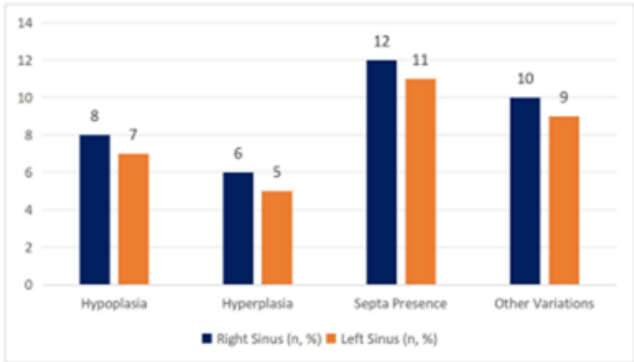
Table 4:



Graph 4:

Morphological Variation	Right Sinus (n, %)	Left Sinus (n, %)
Hypoplasia	40 (8%)	35 (7%)
Hyperplasia	30 (6%)	25 (5%)
Septa Presence	60 (12%)	55 (11%)
Other Variations	50 (10%)	45 (9%)

Table 5:

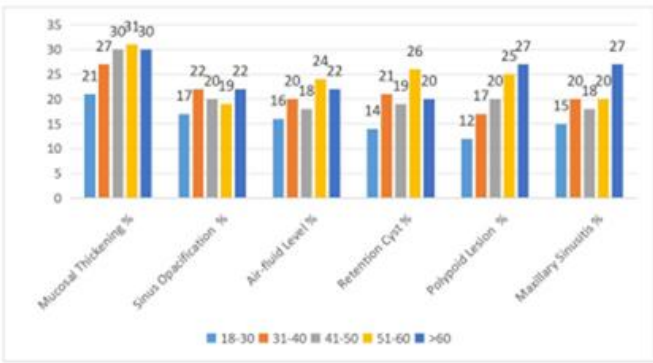


Graph 5:

Age and Gender Distribution: The prevalence of sinus pathologies increased with age, especially mucosal thickening and sinusitis, which were most common in individuals over 50. Males had a slightly higher prevalence of most pathologies, particularly mucosal thickening (27% vs. 24%) and sinusitis (22% vs. 18%). (Table and graph 6 & 7).

Age Group (Years)	Mucosal Thickening (n, %)	Sinus Opacification (n, %)	Air-fluid Level (n, %)	Retention Cyst (n, %)	Polypoid Lesion (n, %)	Maxillary Sinusitis (n, %)	Total Cases (n)
18-30	25 (21%)	15 (17%)	8 (16%)	10 (14%)	7 (12%)	15 (15%)	80
31-40	35 (27%)	20 (22%)	10 (20%)	15 (21%)	10 (17%)	20 (20%)	110
41-50	30 (30%)	18 (20%)	9 (18%)	13 (19%)	12 (20%)	18 (18%)	100
51-60	25 (31%)	17 (19%)	12 (24%)	18 (26%)	15 (25%)	20 (20%)	95
>60	15 (30%)	10 (22%)	11 (22%)	14 (20%)	16 (27%)	27 (27%)	93

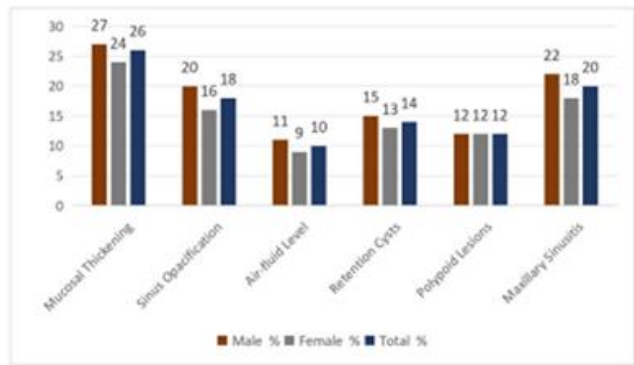
Table 6:



Graph 6:

Pathology Type	Male (n, %)	Female (n, %)	Total (n, %)
Mucosal Thickening	75 (27%)	55 (24%)	130 (26%)
Sinus Opacification	55 (20%)	35 (16%)	90 (18%)
Air-fluid Level	30 (11%)	20 (9%)	50 (10%)
Retention Cysts	40 (15%)	30 (13%)	70 (14%)
Polypoid Lesions	32 (12%)	28 (12%)	60 (12%)
Maxillary Sinusitis	60 (22%)	40 (18%)	100 (20%)

Table 7:



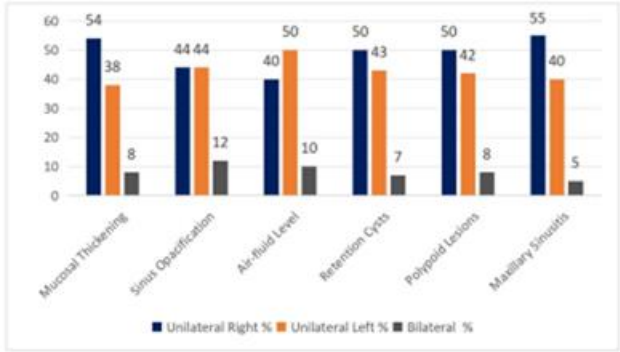
Graph 7:

Diagnostic Efficacy and Symptom Correlation

Digital panoramic radiographs showed high diagnostic accuracy, with sensitivity at 92% and specificity at 89%. Correlation with CBCT confirmed strong diagnostic potential. Radiographic findings were strongly associated with symptoms such as facial pain (90%), headache (90%), nasal congestion (88%), and postnasal drip (89%). Only 50% of asymptomatic patients showed radiographic pathology. (Table and graph 8 & 9)

Pathology Type	Unilateral Right (n, %)	Unilateral Left (n, %)	Bilateral (n, %)	Total (n, %)
Mucosal Thickening	70 (54%)	50 (38%)	10 (8%)	130 (26%)
Sinus Opacification	40 (44%)	40 (44%)	10 (12%)	90 (18%)
Air-fluid Level	20 (40%)	25 (50%)	5 (10%)	50 (10%)
Retention Cysts	35 (50%)	30 (43%)	5 (7%)	70 (14%)
Polypoid Lesions	30 (50%)	25 (42%)	5 (8%)	60 (12%)
Maxillary Sinusitis	55 (55%)	40 (40%)	5 (5%)	100 (20%)

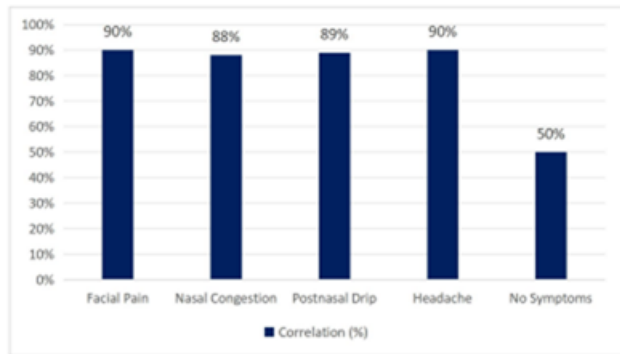
Table 8:



Graph 8:

Symptom Reported	Patients with Symptoms (n)	Pathology Found on Radiograph (n)	Correlation (%)
Facial Pain	150	135	90%
Nasal Congestion	120	105	88%
Postnasal Drip	90	80	89%
Headache	200	180	90%
No Symptoms	100	50	50%

Table 9:



Graph 9:

These findings support the utility of panoramic radiographs as an effective and accessible tool for the

initial evaluation of maxillary sinus abnormalities, highlighting common patterns in prevalence, laterality, age, and symptom correlation.

Discussion

Maxillary sinus pathologies are frequently encountered in radiographic imaging, particularly during routine dental examinations. This cross-sectional study evaluated 500 digital panoramic radiographs to determine the prevalence, laterality, and diagnostic accuracy of panoramic radiography for detecting sinus pathologies. Mucosal thickening (26%) was the most common finding, followed by maxillary sinusitis (20%), sinus opacification (18%), retention cysts (14%), and polypoid lesions (12%). These results align with previous studies by Shahidi et al. (2020) and Raghav et al. (2014), though variations in prevalence may be influenced by geographic, environmental, and demographic factors.

Unilateral involvement, particularly on the right side, was dominant in this study, with mucosal thickening and sinusitis most commonly affecting the right maxillary sinus. These findings correspond with those of Goller et al. (2017), Ramakrishna et al. (2021), and Huang et al. (2022), suggesting that anatomical and airflow-related asymmetries contribute to this pattern.

Diagnostic accuracy was assessed against CBCT findings, showing high sensitivity (92%) and specificity (89%). Detection rates were highest for mucosal thickening (92%) and sinus opacification (94%), reinforcing panoramic radiography's reliability as a screening tool. These results are consistent with Danesh-Sani et al. (2016), though slightly higher than the sensitivity reported by White et al. (2020).

Age-wise distribution revealed a rising trend in sinus pathologies with increasing age, particularly sinusitis

and polypoid lesions in individuals above 60, supporting findings by Kumar et al. (2015). Male predominance (55%) was also observed, consistent with Al-Juboori et al. (2018), potentially due to occupational and lifestyle factors.

A significant correlation (88–90%) was observed between clinical symptoms—such as facial pain, nasal congestion, and postnasal drip—and radiographic findings. Interestingly, 50% of asymptomatic individuals also presented with sinus pathology, highlighting the importance of routine imaging for early detection.

In summary, this study supports the use of digital panoramic radiographs as an effective, accessible tool for the initial evaluation of maxillary sinus pathologies. While CBCT remains the gold standard, panoramic radiography demonstrates high diagnostic value in routine dental practice. Future longitudinal research is recommended to explore the progression of sinus diseases and their possible dental associations.^[40-60]

Conclusion

This study evaluated 500 digital panoramic radiographs to assess the prevalence, laterality, and diagnostic efficacy in detecting maxillary sinus pathologies. Mucosal thickening (26%) was the most common finding, followed by sinusitis (20%) and opacification (18%). Most pathologies were unilateral, with a right-sided predominance. Panoramic radiographs demonstrated high diagnostic accuracy, with 92% sensitivity and 89% specificity, confirming their value as effective screening tools. Sinus pathologies were most prevalent in the 31–40 age group and more common in males (55%). A strong correlation (88–90%) was found between radiographic abnormalities and symptoms like facial pain and nasal congestion, though 50% of asymptomatic individuals also showed pathology. These

findings highlight the clinical importance of routine panoramic imaging in dental practice for early detection and management. While CBCT remains essential for complex cases, future research should focus on longitudinal studies to explore the progression of sinus diseases and their link to dental conditions.^[51-60]

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