e-ISSN: 0975-1556, p-ISSN:2820-2643
Available online on www.ijpcr.com
International Journal of Pharmaceutical and Clinical Research 2024; 16(2); 1849-1856
Original Research Article

CT Evaluation of Paranasal Sinus Lesions

Anurag Das[1], Amulya Kumar Panda[2], B. B. Panda[3]

[1]Postgraduate Resident, Department of Radiodiagnosis, VIMSAR, Burla, Odisha, India
[2]Assistant Professor, Department of Radiodiagnosis, VIMSAR, Burla, Odisha, India
[3]Associate Professor, Department of Radiodiagnosis, VIMSAR, Burla, Odisha, India

Received: 25-12-2023 / Revised: 23-01-2024 / Accepted: 20-02-2024
Corresponding Author: Dr. Amulya Kumar Panda
Conflict of interest: Nil

Abstract:

Background: Paranasal sinus (PNS) lesions encompass a broad spectrum of conditions ranging from benign inflammatory diseases to malignant neoplasms. Accurate diagnosis and effective management of these lesions are critical, as they can considerably impact a patient's quality of life and may lead to severe complications if untreated. Computed tomography (CT) plays a pivotal role in the evaluation of PNS lesions due to its ability to provide detailed visualization of bony and soft tissue structures. The study aims to estimate the efficacy of CT in diagnosing and managing PNS lesions by correlating CT findings with clinical presentations, surgical outcomes, and histopathological results.

Methods: Fifty patients with clinical features suggestive of PNS lesions were included. Each patient underwent comprehensive clinical evaluation, X-ray, and CT scans using both coronal and axial planes. Follow-up included endoscopic examinations, surgical interventions, and histopathological studies. Data were analyzed to establish correlations between clinical and radiological findings.

Results: The study involved 30 males (60%) and 20 females (40%). PNS lesions were most common in individuals aged 31-50 years. Inflammatory conditions accounted for 70% of lesions, while neoplastic lesions accounted for 30%. The maxillary sinus was most commonly affected. CT scans had high diagnostic accuracy, with 85-90% correlation with surgical and histopathological findings. Bone destruction was common in squamous cell carcinoma and fungal infections. CT provided a detailed anatomical roadmap for surgical planning and helped detect complications.

Conclusion: CT imaging is highly effective in diagnosing and managing PNS lesions, providing crucial information that enhances clinical and surgical outcomes. It significantly aids in differentiating between benign and malignant lesions and in planning surgical interventions.

Recommendations: Routine use of CT scans in the evaluation of PNS lesions is recommended for precise diagnosis and effective management. Further studies with larger sample sizes are needed to validate these findings.

Keywords: Paranasal Sinus, Computed Tomography, Inflammatory Diseases, Neoplastic Lesions, Diagnostic Imaging.

Introduction

Paranasal sinus (PNS) lesions encompass a broad spectrum of conditions ranging from benign inflammatory diseases to malignant neoplasms. Accurate diagnosis and effective management of these lesions are critical, as they can substantially impact a patient's quality of life and may lead to severe complications if untreated [1]. Imaging techniques, particularly computed tomography (CT), play a pivotal role in the evaluation of PNS lesions due to their ability to provide detailed visualization of bony and soft tissue structures [2].

CT imaging has revolutionized the diagnostic approach to PNS lesions, offering high-resolution images that facilitate the identification of anatomical variations, the extent of disease, and potential complications. The coronal plane, often preferred by surgeons and endoscopists, provides optimal visualization of the osteomeatal unit (OMU), a critical area in the pathophysiology of chronic rhinosinusitis. Axial imaging complements this by offering additional perspectives, especially in patients who cannot maintain the coronal position [3].

The diagnostic accuracy of CT in differentiating between benign and malignant lesions is well-documented. Studies have shown that CT is particularly effective in identifying the characteristics of various PNS lesions, such as the presence of bony destruction in malignant cases or the hyperdense opacification seen in fungal

infections [4, 5]. Furthermore, CT scans are invaluable in pre-surgical planning, allowing for precise mapping of the lesion's extent and its relationship to adjacent structures.

This study aims to estimate the efficacy of CT in diagnosing and managing PNS lesions by correlating CT findings with clinical presentations, surgical outcomes, and histopathological results. The research seeks to establish the diagnostic yield of CT and its role in the treatment planning of various PNS lesions.

Methodology

Study Design: A hospital based cross sectional study.

Study Setting: The study was taken out in the Department of Radiodiagnosis at V.S.S. Medical College & Hospital, Burla, Sambalpur. The study spanned from November 2019 to October 2021.

Study Population: The study population consisted of 50 patients.

Inclusion Criteria: The study included patients who were referred to the department with a history and clinical features suggestive of lesions in the paranasal sinuses (PNS), from various age groups and of either sex, who presented with paranasal sinus lesions detectable via CT scan.

Exclusion Criteria: Patients without space-occupying lesions (SOL) on CT were excluded from the study.

Study Procedure: Each patient underwent a comprehensive clinical evaluation that included a detailed history and physical examination, followed by an initial X-ray of the paranasal sinuses. The CT scan evaluations were performed using a Canon 160n CT scanner, with both coronal and axial imaging planes being utilized to obtain detailed images of the PNS lesions. For coronal scans, patients were positioned prone with the gantry perpendicular to the hard palate, using a slice thickness of 3mm and scanning from the anterior frontal sinus to the posterior sphenoidal sinus. For axial scans, patients were positioned supine with the gantry parallel to Reid's base line, using a slice thickness of 5mm and scanning from the hard plate through the frontal sinus. The KV settings for coronal and axial scans were 120, with mA settings of 100 and 200, respectively. Bone and soft tissue algorithms were applied to enhance image quality.

In cases where contrast studies were necessary, a bolus of water-soluble ionic iodine-containing dye was administered, with dosages adjusted according to the patient's body weight (1ml/kg for adults and 2ml/kg for children). Non-ionic contrast agents were reserved for patients at risk of adverse reactions to ionic agents. Post-CT evaluations included follow-up endoscopic examinations, surgical interventions, and histopathological studies where applicable. The results from these evaluations were then analyzed and compared.

Data Collection: The data collected from this study encompassed a variety of clinical and radiological parameters, including the patient's clinical presentation, age, sex, lesion site and size, extent of the lesion, bony involvement, invasion into adjacent structures, attenuation values, types of calcification, and contrast enhancement patterns. Specific precautions were taken before subjecting patients to CT scans, such as instructing patients to blow their noses to minimize secretions and improve the visibility of bony structures, removing dentures when applicable, and sedating non-cooperative patients for optimal positioning and evaluation. Patients receiving contrast injections were monitored for 30 minutes post-scan to detect any allergic reactions.

Data Analysis: The collected data were systematically analysed and compared with the results of clinical examinations, X-ray PNS, CT scans, surgical findings, and histopathological studies. This comprehensive analysis aimed to establish correlations between clinical features and radiological findings, thereby validating the efficacy of CT in the diagnosis and management of PNS lesions. The results were synthesized to draw conclusions regarding the diagnostic yield of CT and its role in the clinical management of paranasal sinus lesions, comparing the observations with those reported in other studies to ensure accuracy and reliability.

Figure 1: Showing CANON 160n MDCT scan

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

A total of 50 patients were involved in the study. The patients' clinical history, physical examination, and follow-up surgical and histopathological findings were correlated with the CT results to establish a comprehensive diagnosis.

Table 1: Age and Gender distribution in various PNS lesions

Age in years	Number of patients, n (%)	Male, n (%)	Female, n (%)
11-20	4 (8%)	3 (10%)	1 (5%)
21-30	16 (32%)	10 (33%)	6 (30%)
31-40	10 (20%)	4 (13%)	6 (30%)
41-50	10 (20%)	7 (23%)	3 (15%)
51-60	7 (14%)	5 (17%)	2 (10%)
61-70	3 (6%)	1 (3%)	2 (10%)

The study comprised 30 males (60%) and 20 females (40%), indicating a male-to-female ratio of 1.5:1. The age distribution revealed that PNS lesions were most common in individuals aged 31-50 years, with the least affected age group being 61-70 years.

Patients often presented with multiple symptoms, the most common being headache (64%), nasal obstruction, and discharge (40%). The multiplicity of symptoms was notably higher in cases of carcinoma and fungal infections, typically due to the advanced stage of disease at presentation. The average duration of symptoms before diagnosis was eight months.

Table 2: Occurrence of inflammatory lesions arising from PNS

Lesion	Frequency (%)
Acute/Chronic sinusitis	15 (43%)
Polyp	9 (26%)
Retention cyst	4 (11%)
Allergic sinusitis	4 (11%)
Fungal sinusitis	3 (9%)

Inflammatory conditions accounted for the majority of PNS lesions (70%), followed by neoplastic lesions (30%). Inflammatory lesions were more prevalent in males (60%) than females (40%), with the 21-30 years age group being the most affected.

Among inflammatory lesions, the maxillary sinus was most commonly affected (74.3%), followed by the ethmoid (48.6%), frontal (28.6%), and sphenoid sinuses (25.7%). Acute and chronic sinusitis, retention cysts, fungal sinusitis, and polyps were found to involve multiple sinuses. In this study, 15 patients had acute/chronic sinusitis (43%), 9 had inflammatory polyps (26%), 4 had retention cysts (11%), 4 had allergic sinusitis (11%), and 3 had fungal sinusitis (9%). Among polyps, antrochoanal polyps were found in 5 cases (55.6%) and ethmoidal polyps in 4 cases (44.4%).

Table 3: Age and gender distribution of neoplastic lesions

Age in years	Frequency (%)	Male, n (%)	Females, n (%)
11-20	0	0	0
21-30	0	0	0
31-40	2 (13.3%)	0	2 (33.3%)
41-50	8 (53.3%)	5 (55.6%)	3 (50%)
51-60	4 (26.7%)	3 (33.3%)	1 (16.7%)
61-70	1 (6.7%)	1 (11.1%)	0
TOTAL	15 (100%)	9(100%)	6 (100%)

Neoplastic lesions were observed in 15 patients, with a male-to-female ratio of 1.5:1. The most common age group affected was 41-50 years, with malignancies more prevalent in males aged 41-60 years. The majority of neoplastic lesions were squamous cell carcinoma (73.3%), followed by lymphoma (13.3%) and glandular tumors (13.3%). The maxillary sinus was the most involved site (46.7%), followed by the ethmoid sinus (26.7%). Maxillary sinus involvement was particularly noted in cases of squamous cell carcinoma.

Table 4: Plain CT findings

Lesion	Isodense	Hyperdense	Hypodense	Mixed	Total
Sinusitis	5	0	10	0	15
Polyp	3	0	6	0	9
Mucous retention cyst	1	0	3	0	4
Allergic sinusitis	1	2	1	0	4
Fungal sinusitis	0	3	0	0	3
Squamous cell carcinoma	4	0	4	3	11
Glandular tumor	1	0	1	0	2
Lymphoma	0	0	2	0	2
Total	15	5	27	3	50

On plain CT, 54% of the lesions were hypodense, followed by isodense (30%), hyperdense (10%), and mixed density (6%). In cases of sinusitis, common CT findings included fluid levels and total opacification of the sinuses, with no enhancement seen on contrast. Polyps appeared as bulky, soft tissue masses with chronic mucosal thickening and mild irregular enhancement. Mucous retention cysts and allergic sinusitis exhibited characteristic CT appearances.

Table 5: Involvement of contiguous structures

Lesions	Bony changes				Orbital extension	Intracranial extension
	Remodel-ling	Hyperostosis	Erosion	Destruction		
Sinusitis	0	0	0	0	2	0
Polyp	1	0	0	0	0	0
Retention cyst	1	0	0	0	0	0
Allergic sinusitis	0	0	0	0	0	0
Fungal sinusitis	1	0	1	2	0	2
Squamous cell carcinoma	2	1	4	9	0	1
Glandular tumor	1	0	0	2	1	0
Lymphoma	0	0	0	1	0	0
TOTAL	6	1	5	14	3	3

Bone destruction was the most common bony change, observed in 14 cases, predominantly in squamous cell carcinoma and fungal infections. Orbital involvement was most frequently seen in squamous cell carcinoma (50%), followed by acute/chronic sinusitis and lymphoma. Intra-cranial involvement was noted in 6 cases, with fungal sinusitis being the most common among them.

Table 6: Correlation of CT finding with final diagnosis

Lesion	CT diagnosis	Final diagnosis
Sinusitis	15	12
Polyp	9	11
Retention cyst	4	5
Allergic sinusitis	4	5
Fungal sinusitis	3	2
Squamous cell carcinoma	11	11
Glandular tumor	2	2
Lymphoma	2	2
Total	50	50

The CT diagnosis was found to be precise in 85-90% of the cases. However, some cases of sinusitis, polyps, and retention cysts were misdiagnosed. CT scans provided a detailed anatomical roadmap for surgical planning and helped detect associated complications that might not have been otherwise identified.

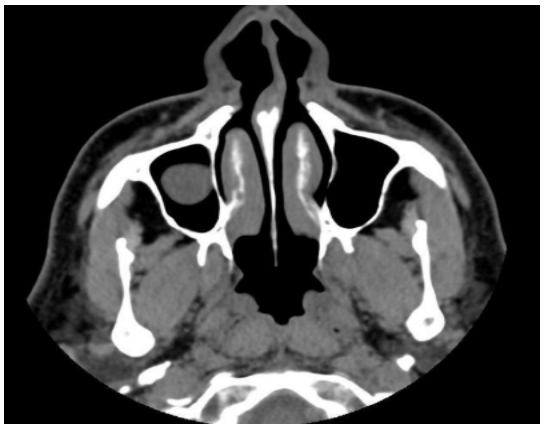

Figure 2: Showing mucuos retention cyst. A well marginated homogenous, isodense mass in tight maxillary sinus noted.

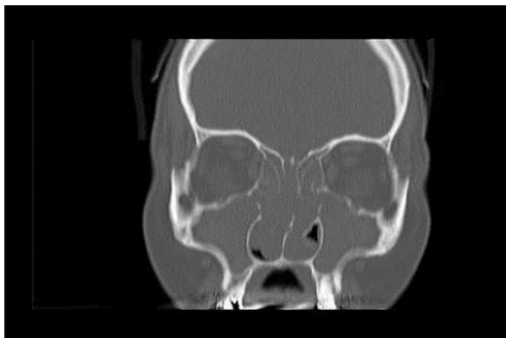

Figure 3: Showing sinonasal polyposis. Soft tissue mass filling the B/L maxillary sinus, nasal cavity, ethmoid sinus

Figure 4: Showing fungal sinusitis. Hyperdense lesion noted in bilateral ethmoid sinus.

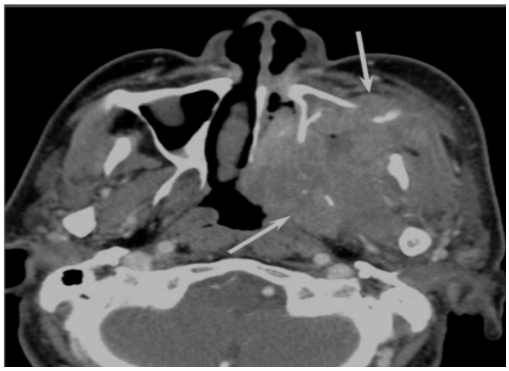

Figure 5: Showing squamous cell carcinoma. Heterogeneously enhancing soft tissue mass in maxillary sinus with aggressive bony destruction into nasal cavity, pterygoid plates, nasopharynx.

Discussion

This study evaluated 50 patients with paranasal sinus (PNS) lesions using clinical history, physical examinations, CT scans, and follow-up surgical and histopathological findings. The cohort included 30 males (60%) and 20 females (40%), with the majority of lesions observed in individuals aged 31-50 years. Headache (64%) and nasal obstruction/discharge (40%) were the most common symptoms, often presenting in advanced stages of carcinoma and fungal infections, with an average symptom duration of eight months.

Inflammatory conditions comprised 70% of PNS lesions, more prevalent in males (60%) and primarily affecting the 21-30 years age group. The maxillary sinus was the most commonly affected site (74.3%), followed by the ethmoid (48.6%), frontal (28.6%), and sphenoid sinuses (25.7%). Acute/chronic sinusitis (43%), inflammatory polyps (26%), retention cysts (11%), allergic sinusitis (11%), and fungal sinusitis (9%) were the primary inflammatory conditions, with antrochoanal polyps more common than ethmoidal polyps.

Neoplastic lesions accounted for 30% of cases, with a male-to-female ratio of 1.5:1, most common in the 41-50 years age group. Squamous cell carcinoma was the predominant neoplastic lesion (73.3%), followed by lymphoma (13.3%) and glandular tumors (13.3%). The maxillary sinus was the most frequently involved site for neoplastic lesions (46.7%).

CT scans revealed that 54% of lesions were hypodense, 30% isodense, 10% hyperdense, and 6% mixed density. Common CT findings in sinusitis included fluid levels and total sinus opacification, with polyps appearing as bulky masses with mucosal thickening and mild enhancement. Mucous retention cysts and allergic sinusitis had characteristic CT appearances.

Bone destruction was observed in 14 cases, mainly in squamous cell carcinoma and fungal infections. Orbital involvement was most frequent in squamous cell carcinoma (50%), followed by sinusitis and lymphoma. Intra-cranial involvement was noted in 6 cases, predominantly in fungal sinusitis.

CT diagnoses were precise in 85-90% of cases, providing detailed anatomical maps for surgical planning and detecting complications not identified by other means. Some cases of sinusitis, polyps, and retention cysts were misdiagnosed, but CT scans proved invaluable in clinical management.

The study confirms the efficacy of CT in diagnosing PNS lesions, highlighting its ability to provide detailed imaging that correlates well with clinical and histopathological findings. CT's high diagnostic precision, particularly for distinguishing between benign and malignant lesions and for identifying the extent of disease involvement, underscores its importance in the clinical management of PNS lesions. The data suggest a higher prevalence of PNS lesions in males and a significant incidence of inflammatory conditions, with squamous cell carcinoma being the most common neoplastic lesion. The results also demonstrate CT's crucial role in surgical planning and the detection of associated complications.

Recent studies have emphasized the importance of CT imaging in the accurate diagnosis and treatment of paranasal sinus lesions. A study demonstrated that CT scans had higher sensitivity (94%), specificity (96%), positive predictive value (95%), and negative predictive value (94%) in diagnosing anatomical variants, chronic sinusitis, and sinonasal polyps compared to clinical diagnosis. Although CT was less sensitive for fungal sinusitis, it was highly effective in detecting bone involvement by PNS lesions [6].

In another study, highlighted the utility of CT scans in evaluating chronic rhinosinusitis, noting that it is the most reliable radiological examination to identify a fungus ball and assess the severity of the disease. Their prospective study on 30 patients found that CT scans were instrumental in diagnosing chronic sinusitis (43.3%), polyps

(23.3%), and fungal sinusitis (16.7%). The maxillary sinus was most frequently involved (83.5%), followed by the ethmoid sinus (74.7%) [7].

A study including 104 patients discovered that CT imaging offered comprehensive details about the extent, location, and involvement of tumours. The study found that when it came to identifying anatomic variations and neoplastic lesions, CT diagnosis had a 92% sensitivity, 95% specificity, 94% positive predictive value, and 93% negative predictive value. For the purpose of surgical planning and lowering complications during FESS, this high diagnostic accuracy was essential [8].

A hospital-based observational study evaluated 44 patients and confirmed that CT findings were consistent with surgical findings in 84.6% of cases. The study noted that the most common anatomical variation was a deviated nasal septum (68.2%), and the maxillary sinus was most frequently involved (90.9%). CT scans proved particularly useful in identifying sinonasal polyposis and chronic rhinosinusitis [9].

A study on 96 patients revealed that common pathologies detected by CT included inflammatory conditions (41.7%), sinusitis (33.3%), neoplastic lesions (8.3%), polyposis (6.3%), and sinus hypoplasia (5.2%). CT scans were particularly valuable in assessing the detailed preoperative anatomy for FESS [10].

Research assessing unilateral sinonasal lesions in one hundred individuals discovered that in cases of malignant tumours, the right maxillary sinus and nasal cavity were most severely damaged. The study noted that preoperative biopsy was considerably greater in the group with malignant tumours ($p=0.001$), underscoring the significance of utilising endoscopy and CT/MRI for correct diagnosis [11].

Conclusion

The study demonstrated that CT is a highly effective diagnostic tool for PNS lesions, providing detailed imaging that correlates well with clinical, surgical, and histopathological findings. The results underscore the importance of CT in diagnosing and managing PNS lesions, aiding in accurate disease staging and treatment planning.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Routine use of CT scans in the evaluation of PNS lesions is recommended for precise diagnosis and effective management. Further studies with larger sample sizes are needed to validate these findings.

Acknowledgement: We are thankful to the patients; without them the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in patient care of the study group.

List of abbreviations:

PNS: Paranasal sinus

CT: Computed tomography

OMU: osteomeatal unit

SOL: space-occupying lesions

Source of funding: No funding received.

References

1. Lloyd, G. A. S. Imaging for paranasal sinus disease. Radiologic Clinics of North America, 2015;53(1):9-23.
2. Rosenfeld, R. M., Piccirillo, J. F., Chandrasekhar, S. S., Brook, I., Kumar, K. A., Kramper, M., & Corrigan, M. D. Clinical practice guideline (update): Adult sinusitis. Otolaryngology–Head and Neck Surgery, 2015; 152(2 Suppl): S1-S39.
3. Weber, R. K., Hosemann, W., & Draf, W. Modern concepts of frontal sinus surgery. Laryngo-Rhino-Otologie, 94(S 01), S12 1-S158.
4. Geaney, G. P., Farooq, A. V., & Bilyk, J. R. Imaging of orbital and periorbital disease. Current Opinion in Ophthalmology, 2018; 29(5): 506-516.
5. Jeyakumar, A., Brickman, T. M., & Gutsche, A. R. Evaluation of computed tomography in pediatric chronic rhinosinusitis. International Journal of Pediatric Otorhinolaryngology, 2016;89: 145-148.
6. Vijayprabhu, R., Adaikappan, M., & Sethurajan, S. Computed Tomographic Evaluation of Paranasal Sinus and Pathologies. Journal of Evolution of medical and Dental Sciences, 2015;4:5741-5747.
7. Srivastava, M., Singh, H., Ahmed, W., & Agarwal, S. Role of CT scan in paranasal sinus pathology. IP Indian Journal of Anatomy and Surgery of Head, Neck and Brain. 2019.
8. Chandan, G. Occurrence of benign tumors of the paranasal sinuses by computed tomography study in Karnataka. Journal of drug discovery and therapeutics, 2015;3.
9. Sharma, B., Ob, P., Lohani, B., & Khanal, U. Computed Tomography in the Evaluation of Pathological Lesions of Paranasal Sinuses. Journal of Nepal Health Research Council, 2015;13(30): 116-20.
10. Monagari, P. Utility of CT scan in Assessment of Paranasal Sinus Pathology. Asian Journal of Medical Research. 2019.

11. Marzouk, M., Ebeid, K., El-sheikh, M., & Hegazy, H. Evaluation of Unilateral Sinonasal Lesions. Journal of Advances in Medicine and Medical Research. 2022.