Original Research Article

Diagnostic accuracy of contrast enhanced computed tomography in evaluation of paranasal sinus pathologies

Rohit Arora[1*], Bikramaditya Swain[2], Kamal K. Sen[3], Sangram Panda[4], Roopak Dubey[5], Mayank Goyal[6]

[1]Junior Resident, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

[2]Associate Professor, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

[3]Professor and Head, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

[4]Assistant Professor, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

[5]Junior Resident, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

[6]Junior Resident, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

Received: 15-09-2021 / Revised: 19-10-2021 / Accepted: 13-12-2021

Abstract

Background: The diseases of the Para Nasal Sinuses (PNS) cover a wide range of illnesses, from inflammatory conditions to benign and malignant neoplasms with wide range of symptoms from mild headaches to severe symptoms due to intracranial, intra temporal or intra orbital extensions. Contrast enhanced computed tomography (CECT) has been the imaging method of choice in the pre-operative examination of patients who are candidates for functional endoscopic sinus surgery (FESS), also known as Screening sinus CT(SSCT). **Aim:** This study aims to evaluate the Paranasal sinus (PNS) pathologies on Contrast Enhanced Computerised Tomography (CECT) and to correlate CECT findings with eventual histopathological findings to evaluate diagnostic accuracy of the modality. **Materials and methods:** This study included CECT evaluation of 50 patients with clinically suspected paranasal sinus pathologies and clearly demonstrated a very high diagnostic accuracy of CECT PNS for evaluation of various paranasal sinus pathologies. A structured pre-prepared case proforma will be used to enter the patient details, detailed clinical history related to paranasal sinus pathologies, physical examination of patients who meet the inclusion criteria. **Results:** In the present study, patient ranged between 9-67 years. Maximum number of cases 36% belongs to the age group 21-30 years followed by 31-40 years (20%).The maxillary sinus was the most commonly affected sinus in this study in 44 patients (88%), followed by the anterior ethmoid (78%), posterior ethmoid (66%), frontal sinus (52%) and least affected was sphenoid sinus (42%). Inflammatory polyp has a sensitivity of 100% and a specificity of 94.2% when comparing CECT diagnosis to histopathology. The sensitivity of benign lesions is 78.5% and the specificity is 100%. CECT has a lower sensitivity of 66.6% and a higher specificity of 100% for diagnosing fungal sinusitis with a diagnostic accuracy of 94%. CT offers 100% sensitivity for identifying malignant and non-specific inflammation. **Conclusion:** CECT is also imaging modality of choice for evaluation of anatomic variants present in nose and paranasal sinuses which must be known to a surgeon before surgery to avoid intra operative and post operative complications, Hence preoperative CECT serves as a ROAD MAP to functional endoscopic sinus surgery.

Keywords: Para Nasal Sinuses (PNS), Contrast enhanced computed tomography (CECT), functional endoscopic sinus surgery (FESS), Contrast Enhanced Computerised Tomography (CECT)

Introduction

The diseases of the Para Nasal Sinuses (PNS) cover a wide range of illnesses, from inflammatory conditions to benign and malignant neoplasms[1]. PNS pathologies can cause a wide range of symptoms from mild headaches to severe symptoms due to intracranial, intra temporal or intra orbital extensions[2]. In the diagnosis of non-neoplastic and neoplastic PNS disorders, plain film is erroneous and insufficient. Imaging of the PNS has mostly moved away from traditional radiography (plain films) and toward Contrast enhanced computed tomography (CECT) and magnetic resonance imaging (MRI).

*Correspondence
Dr. Rohit Arora
Junior Resident, Department of Radio-Diagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India
E-mail: arorarohit0810@gmail.com

The advancement of technology in these two imaging modalities has allowed for more exact differential diagnosis and better detail regarding the anatomic extent of PNS disorders. In the case of PNS disease, these provide significant information for diagnosis and surgical planning.

A complete axial and coronal CECT scan series is an excellent and thorough way to assess PNS. The morphology, anatomic variations, and pathophysiology of the PNS are all well-documented. When it comes to analysing tiny bone features, fibro-osseous lesions of the PNS, and sino facial injuries, CECT outperforms MRI. Since the introduction of functional endoscopic sinus surgery (FESS), CECT has been the imaging method of choice. CECT is used in the pre-operative examination of patients who are candidates for FESS, also known as SSCT (Screening sinus CT)[3]. The evaluation of the PNS and nose before FESS is now a medico legal requirement, as it gives a "ROAD MAP" for the otolaryngologist to follow throughout surgery and directs the surgical strategy. CECT determines the extent and

distribution of disease and detects anatomic variations (such as septal deviation, spur formation, concha bullosa, paradoxical curve of middle turbinate, etc.) that may put patients at risk for intra-operative and post-operative FESS complications, lowering morbidity and mortality. Imaging of space-occupying lesions has been revolutionized due to CECT's unique ability to image both bones and soft tissues, as well as direct coronal scanning and sagittal reconstruction[4]. In the examination of paranasal sinus disorders, a combination of CECT and diagnostic endoscopy has become the gold standard. As a result, CECT is quite valuable and provides standard imaging of paranasal sinus illness.

Materials and methods

A prospective correlational descriptive clinical study of 50 patients who underwent CECT PNS with clinically suspected lesions involving the paranasal sinuses and the nasal pathway and correlated with HP. 50 consecutive patients with clinical suspicion of paranasal sinus pathologies referred for evaluation by CECT PNS to the department of Radiodiagnosis.

Informed written consent obtained from the patients referred to Dept. of Radiodiagnosis with clinically suspected paranasal sinus pathologies for evaluation by CECT PNS. A structured pre-prepared case proforma will be used to enter the patient details, detailed clinical history related to paranasal sinus pathologies, physical examination of patients who meet the inclusion criteria.

Position of patient

Patient will be placed in supine position with arms on patient's side on CT table.

CT Acquisition Technique

Evaluation was be done with 64 slices Multidetector Computerised Tomography (G E Optima) and non-ionic contrast Iopromide (1.5 ml/Kg body weight) injected intravenously with pressure injector at the rate of 4cc/sec using 18G IV catheter. First non enhanced CT scan axial sections were obtained from the hard palate to the end of frontal sinus with a section width of 5 mm, following which contrast was injected and scanning was undertaken in the arterial phase (35-40sec). Reconstruction of the images with 1.25mm sections was done in coronal and sagittal planes.

CT Image Analysis

All the CT images were analysed for Sinus Involved , Anatomical Variants, Septal Deviation, Turbinate Hpertrophy , OMU Obstruction, Nasal Cavity Involcement , Choanal Involvement, Bony Involvement, Hemosinus/ Calcification/ Enhancement +/- and Intraorbital/ Intratemporal/ Intracranial Extension.

Statistical analysis

Data was entered in Microsoft excel and analysis was done using SPSS version 20. Descriptive statistical analysis was done . Results on continuous measurements are presented as Mean & Standard Deviation. Results on categorical measurements are presented as Percentages.

Results

A prospective correlational descriptive clinical study of 50 patients who underwent CECT PNS with clinically suspected lesions involving the paranasal sinuses and the nasal pathway and correlated with HP. Highest number of patients were in the range of 21-30 years (36%) followed by 31-40 years (20%).

In this study most common involved sinus is maxillary sinus (88%). DNS was seen in 24 patients (48.0%) with more common towards right side. Concha Bullosa noted in 16 patients (32%) with more common on right side. Concha Bullosa seen in 6 patients (12%) and OMU obstruction is observed in 38 patients (76%).

On CECT evaluation, Inflammatory polyps was most common diagnosis accounting for 17 (34%) of total patients followed by benign neoplastic lesions in 11 (22%), non specific inflammation in 10 (20%) and least common were fungal sinusitis and malignant neoplastic lesions in 6 (12%) patients. *(Table 1)*

On histopathology, Inflammatory polyps were most common in 15 (30%) patients followed by benign neoplastic lesions in 14 (28%), fungal sinusitis in 9 (18%), non specific inflammation in 8 (16%) and least common diagnosis was malignant neoplastic lesions in 4 (8%) patients.

Diagnostic accuracy of CECT was 94% in fungal sinusitis and benign neoplastic lesions and 96% in detecting other paranasal pathologies with a high sensitivity in detecting inflammatory etiologies and malignant neoplastic lesions and a low sensitivity for diagnosing fungal sinusitis and benign neoplastic lesions. *(Table 2)*

Maximum number 14 (28%) of patients had Lund Mackay scores between 16-20 and minimum number 6 (12%) of patients had scores between 21-24. *(Table 3)* number 6 (12%) of patients had scores between 21-24.

Table1: Comparison of CECT and HP diagnosis

Diagnosis	CECT		HP	
	No.	%	No.	%
Inflammatory polyp	17	34	15	30
NSI	10	20	8	16
Fungal sinusitis	6	12	9	16
Benign	11	22	14	26
Malignant	6	12	4	8

Table 2: Correlation of CECT with HP - an evaluation

Parameters	SN	SP	PPV	NPV	Accuracy
Inflammatory polyp	100	94.2	88.2	100	96
NSI	100	95.2	80	100	96
Fungal sinusitis	66.6	100	100	93.1	94
Benign	78.5	100	100	92.3	94
Malignant	100	95.6	66.6	100	96

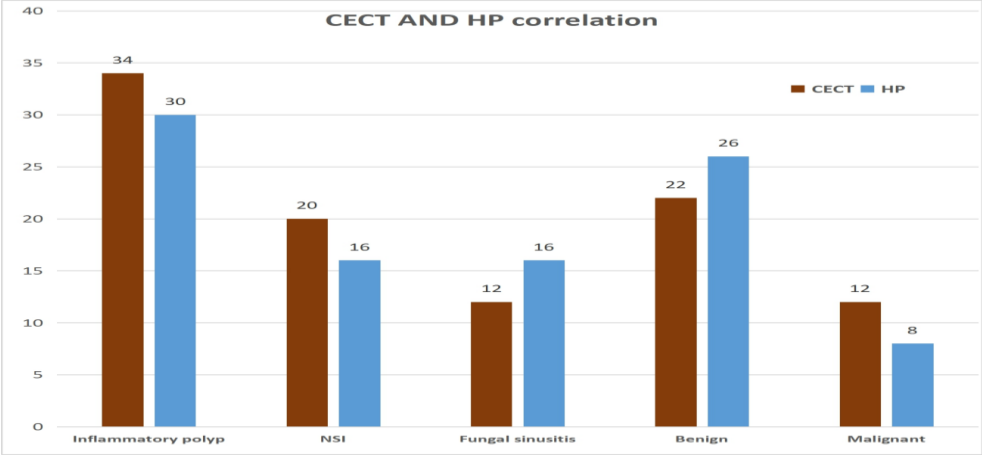

Fig 1: Comparison of CECT and HP diagnosis

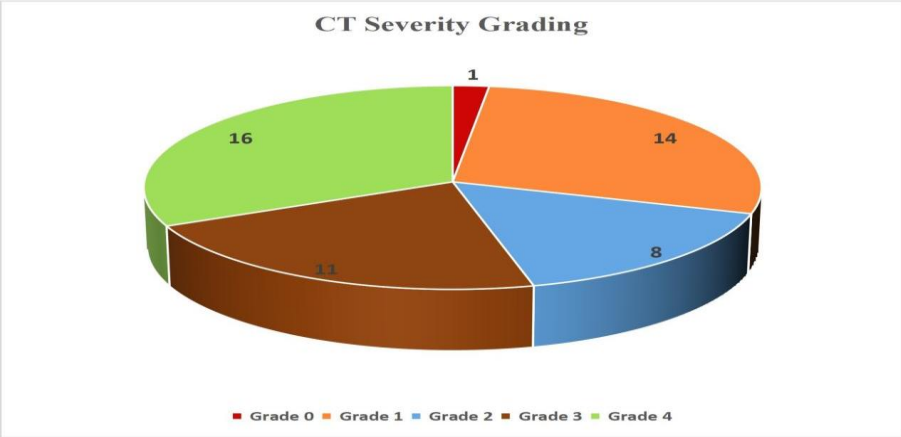

Fig 2: CT Severity Grading

Table 3: Lund Mackey system

Sinus	Right	Left
Frontal	0-2	0-2
Anterior ethmoid	0-2	0-2
Posterior ethmoid	0-2	0-2
Maxillary	0-2	0-2
Sphenoid	0-2	0-2
OMU	0 or 2	0 or 2

Sinuses: 0 = No abnormality, 1 = Partial opacification, 2 = Total opacification
OMU: 0 = Occluded, 2 = Not occluded

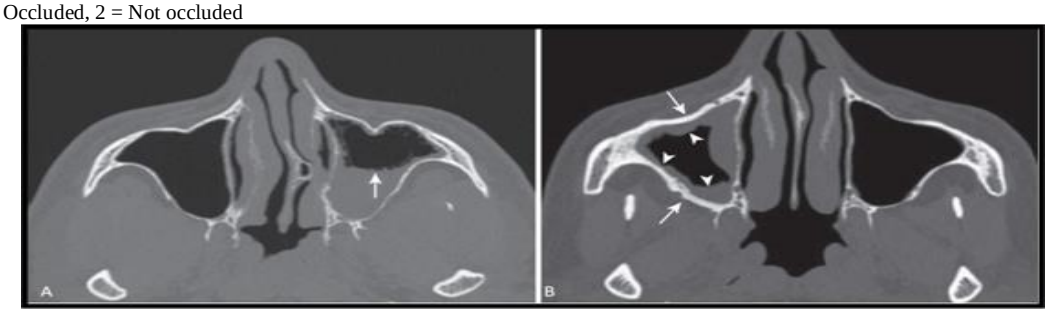

Figure-3: Axial(A) CT PNS (bone window) scan shows mucosal thickening in left maxillary sinus with secretions and air fluid level suggesting acute left maxillary sinusitis. Axial(B) PNS (bone window) scan shows concenteric mucosal thickening in right maxillary sinus with bone remodelling of surrrounding bony walls of right maxillary sinus (arrows) seen in chronic sinusitis.

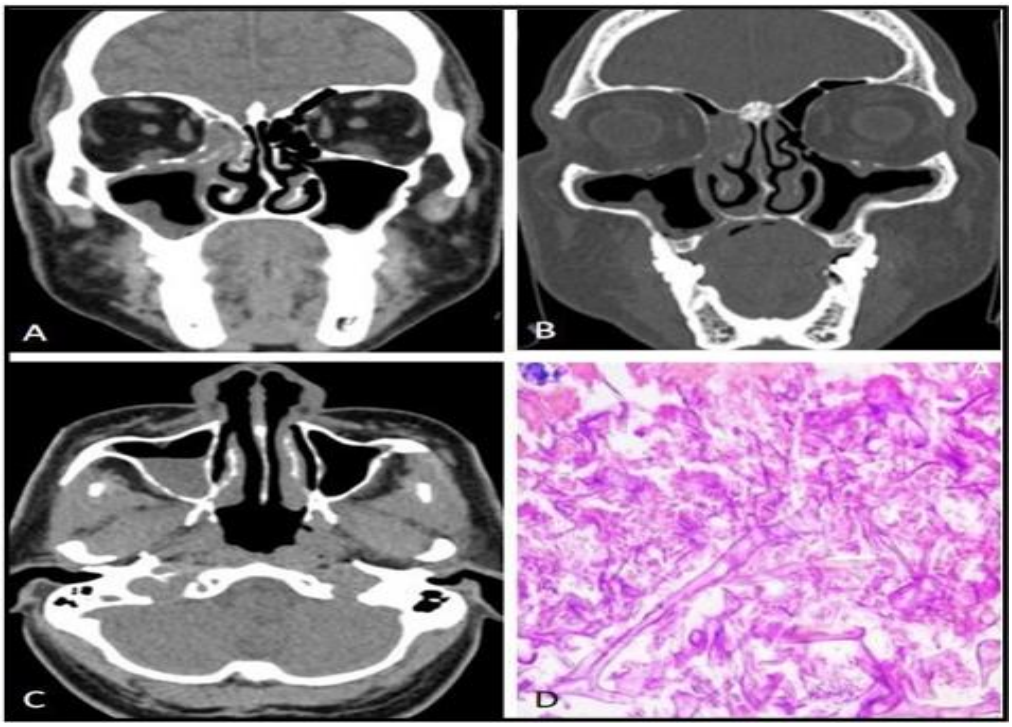

Figure-4: Coronal(A), Coronal(B), Axial(C) CT PNS scan shows mucosal thickening in right maxillary sinus with air fluid level causing mild erosion of superior and inferior wall with extension into the right orbitand retromaxillary area suggesting acute invasive fungal sinusitis. Histopathology smear from right maxillary sinus showing broad nonseptate hyphae of Mucor.

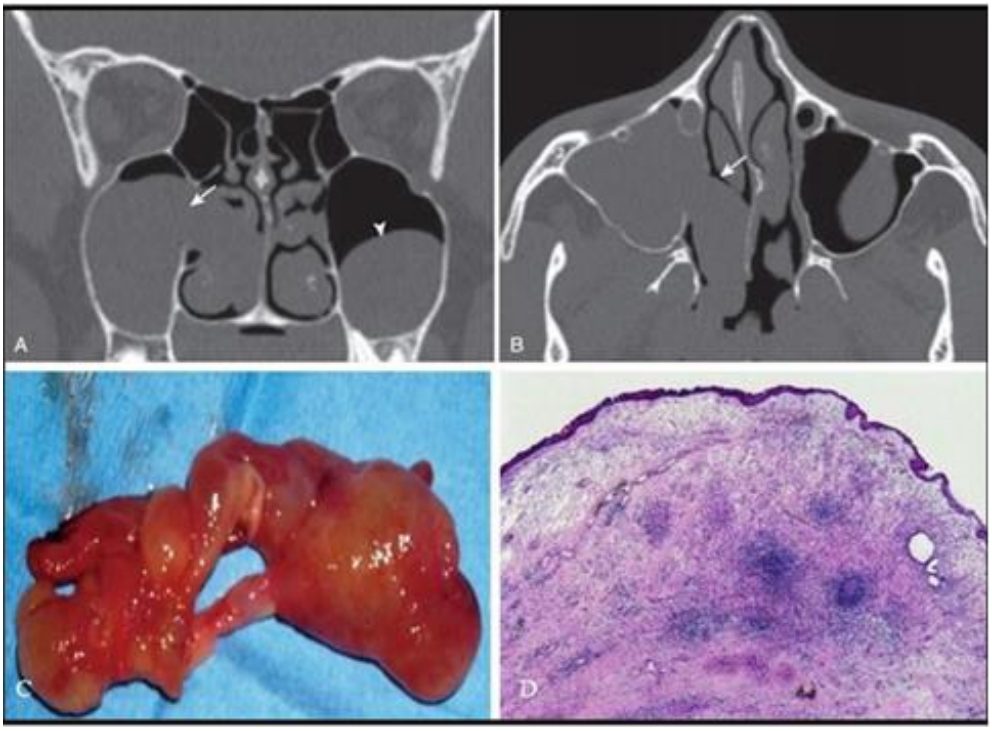

Fig.3: Antrochoanal polyp arising in right maxillary sinus with polypoidal mucosal thickening in left maxillary sinus in a 35yr old male patient came with complaints of nasal blockage and headache. Coronal(A), Axial(B) CT PNS (bone window) scan shows well defined mass arising in right maxillary sinus causing widening of right maxilaary ostium extending into right half of nasopharynx reaching upto right choana without causing any bony destruction(arrows). Gross specimen(C) and (D) AC polyp with conspicuous fibrous stroma surrounding the wall of blood vesssels and lack of significant eosinophilic infiltrate

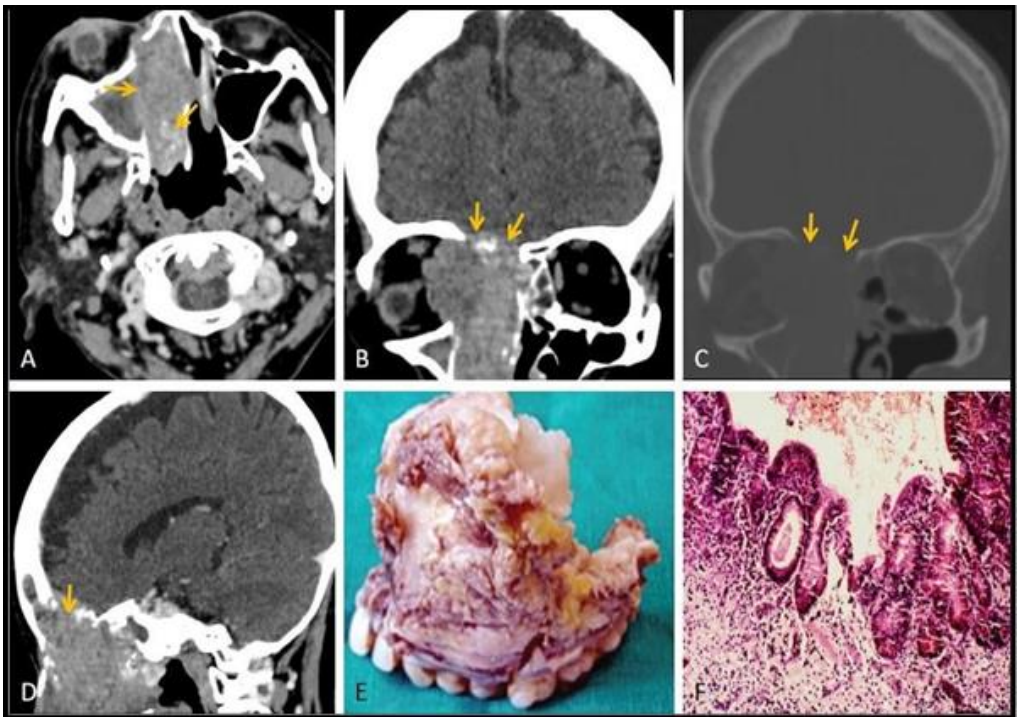

Fig.4: Adenocarcinoma arising in right maxillary sinus in a 55yr old male patient camewith complaints of nasal blockage, headache, diplopia and propstosis. Axial(A), Coronal(B), Sagittal(D) CECT PNS (soft tissue window) scan shows heterogenously enhancing mass arising in right maxillary sinus Coronal(C) CT PNS (bone window) eroding the surrounding bony structures extending into nasal cavity, nasopharynx, right orbit and anterior cranial fossa (arrows). Gross specimen(E) and Intestinal type adenocarcinoma with abundant presence of paneth cells(F).

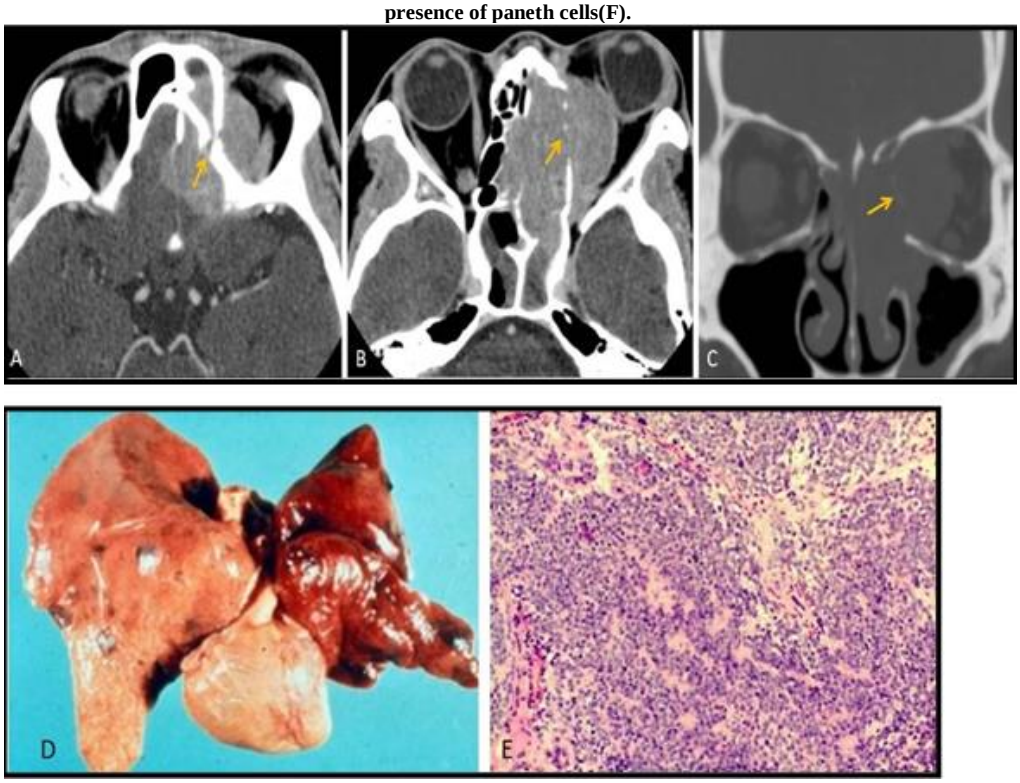

Fig.5: Olfactory Neuroblastoma in a 12yr old female patient came with complaints of nasal stuffiness, headache, proptosis and rhinorrhoea. Axial(A), Axial(B) and Coronal(C) CECT PNS scan shows heterogenously enhancing mass arising in nasal cavity and left sphenoid sinus eroding the surrounding bony structures extending into leftorbit (arrows). Gross specimen(E) polypoid mass of fleshy consistency and pink color and Histopathology smear shows neuroblasts appear separated by a neurofibrillary matrix (F).

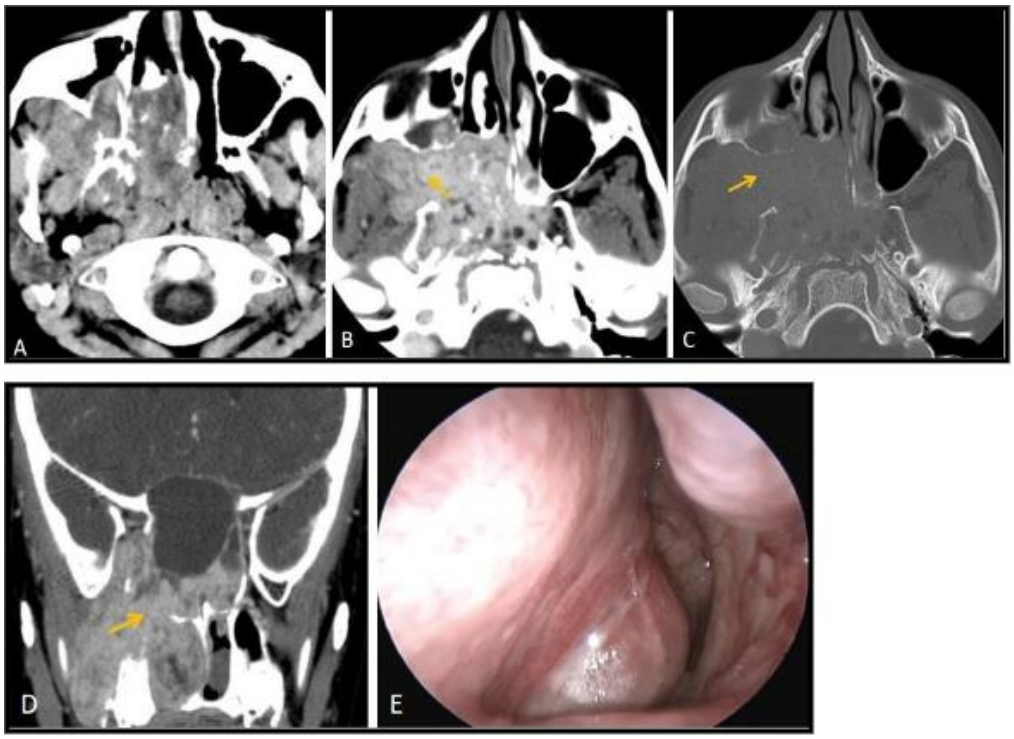

Fig.6: Juvenile Nasopharyngeal angiofibroma in a 29yr old female patient came with complaints of nasal stuffiness, headache and epistaxis. Axial(A), Axial(B), Axial(C) and Coronal(D) CECT PNS scan shows vividly enhancing mass arising in nose, nasopharynx and right maxillary sinus eroding the surrounding bony structures extending into middle cranial fossa and surrounding soft tissues (arrows). Endoscopy image(E) shows mass in nasal cavity .

Discussion

Paranasal sinuses are air-filled extensions of the nasal cavity formed as a result of erosion of surrounding bones from the nasal cavity during development[5]. Paranasal sinuses drain back into nasal cavity through the meatus in roof and lateral nasal walls. Functions include lightening the weight of the head, supports immune defence of the nasal cavity, humidifies inspired air and increases resonance of the voice[6].

Nose and paranasal sinuses are affected by a wide spectrum of diseases ranging from inflammatory conditions to neoplasm, both benign and malignant[7]. For diagnosing and management of the pathologies understanding the normal anatomy, anatomic variants and physiology of this paranasal sinuses is necessary, hence imaging plays an important to categorize the spectrum of disease, detect the involvement of sinuses and extension of the disease. X-rays had its own limitations in evaluation of PNS. Presently technology has evolved to a point where virtual endoscopy of the sinuses can be performed to see normal anatomy and the pathologies. Contrast enhanced computed tomography (CECT) remains the modality of choice in evaluation of paranasal sinuses and pathologies[8]. The present study was done on 50 patients, referred for CECT PNS with clinically suspected paranasal sinus pathologies and to correlate CECT findings with eventual histopathology findings to evaluate diagnostic accuracy of the modality. CECT evaluation of patients with clinically suspected para nasal sinus pathologies is today widely recognized as the best imaging technique to identify a broad range of conditions, from mild inflammatory illnesses to tumors in the para nasal sinuses[9]. Previous studies has revealed a poor correlation between conventional X-ray and CT[10]. Clinical evaluation should be performed to identify acute sinus infection, and CECT should be utilized to investigate persistent and chronic sinus illness that is resistant to medical treatment. Plain radio graphs are unable to assess the complicated anatomy of the para nasal sinuses and the osteomeatal complex. The fundamental concept of FESS is to remove the disease from the osteomeatal complex area, which can be best evaluated on a CECT scan[11]. In the present study, patient ranged between 9-67 years. Maximum number of cases 36% belongs to the age group 21-30 years. Age-wise distribution was consistent with the previous study by Chakraborty P et al. in 2016[12]. DNS was found in 24 of 50 patients, accounting for 48% of the total. Concha bullosa was seen in 30 patients (28.8%) and OMU obstruction was found in 73 (70.2%) of the patients, with bilateral involvement being more common than unilateral involvement. As a result, there was no difference in the overall incidence of inflammatory pathologies in the Osteomeatal complex in symptomatic individuals with and without concha bullosa and this is consisitent with previous study by Kanwar SS et al[13].

The maxillary sinus was the most commonly affected sinus in this study in 44 patients (88%), followed by the anterior ethmoid (78%), posterior ethmoid (66%), frontal sinus (52%) and least affected was sphenoid sinus (42%). The current research is consistent with a subsequent study by Kushwah et al.[14] in which more than 50 individuals were examined and all of them received FESS. The most frequent sites of involvement were maxillary and anterior ethmoid sinuses. The sphenoid was the least engaged in previous study, which is consistent with this study. A greater number of patients with a Lund Mackay score of 16-20 (24 %) were found. Diagnostic accuracy of CECT was 94% in fungal sinusitis and benign neoplastic lesions and 96% in detecting other paranasal pathologies with a high sensitivity in detecting inflammatory etiologies and malignant neoplastic lesions and a low sensitivity for diagnosing fungal sinusitis and benign neoplastic lesions. Zenreich SJ et al[15], a retrospective research, reported a sensitivity of 76 percent for diagnosing fungal sinusitis in the literature. The major pitfall in evaluation of PNS pathologies by CECT was to detect fungal sinusitis. False positives are common since there is increased density also seen in inspissated secretions, calcifications in bacterial infection, and other conditions. False negatives are noticed because in certain instances there will be no increase in density. Fungal sinusitis may mimick a malignant lesion

due to bony erosion and thus accounted for low sensitivity of CECT to diagnose it. However, CT is useful in detecting the invasion of surrounding structures in fungal sinusitis, such as dissemination to neighboring tissues, bone erosion, or destruction. In comparison to other imaging modalities, CECT can identify bone erosion or disintegration with the greatest precision. CT showed a 88.2% sensitivity and 100% specificity for detecting bone erosion or destruction. The CECT has a distinct edge over the MRI in this area. When a malignant tumor is causing bone deterioration, CECT and MRI can be used complimentary each other. CECT showed near-perfect sensitivity and specificity, with the exception of fungal sinusitis and malignant neoplastic lesions.

Virtual endoscopy is now considered a complementary technique to the standard axial and coronal CT scans. It effectively demonstrates the anatomy of these structures and demonstrates areas that are difficult to see with traditional endoscopy.

Even with the above mentioned limitations CECT plays an important role in diagnosing and also adding important findings for the better management of the patients with paranasal sinus diseases.

Conclusion

This study included CECT evaluation of 50 patients with clinically suspected paranasal sinus pathologies and clearly demonstrated a very high diagnostic accuracy of CECT PNS for evaluation of various paranasal sinus pathologies. CECT is also imaging modality of choice for evaluation of anatomic variants present in nose and paranasal sinuses which must be known to a surgeon before surgery to avoid intra operative and post operative complications, Hence preoperative CECT serves as a road map to functional endoscopic sinus surgery.

CT is the most preferred imaging modality for assessing bone erosion and bone thinning of surrounding bony structures and subsequent contrast study helps to depict the intracranial, intratemporal and intraorbital extensions. CECT PNS was able to detect various paransal patholgies ranging from inflammatory, infective diseases and benign and malignant neoplastic lesions with a very high diagnostic accuracy. Virtual endoscopy effectively demonstrates the anatomy of these structures and demonstrates areas that are difficult to see with traditional endoscopy.

Study results revealed that CECT is an excellent imaging modality for evaluating the normal anatomy, variants, and pathologies of the paranasal sinuses. Thus in all the patients prsenting with clinically suspected paranasal sinus pathologies evalauation by CECT PNS must be done before patient undergoes the surgical management.

Conflict of Interest: Nil Source of support: Nil

References

1. Kandukuri R, Phatak S. Evaluation of sinonasal diseases by computed tomography. Journal of clinical and diagnostic research: JCDR. 2016 Nov;10(11):TC09.
2. Vijay PR, Adaikappan M, Sethurajan S. Computed tomographic evaluation of paranasal sinus and pathologies. Journal of Evolution of Medical and Dental Sciences. 2015;4(33):5741-8.
3. Hoang JK, Eastwood JD, Tebbit CL, Glastonbury CM. Multiplanar sinus CT: a systematic approach to imaging before functional endoscopic sinus surgery. American journal of roentgenology. 2010;194(6):W527-36.
4. Dewan K, Ray R, Nag D, Mullick MG, Mukhopadhyay S. Clinico-pathological evaluation of sinonasal neoplasm in a tertiary care hospital. J Dent Med Sci. 2013;6:20-6.
5. Singh AK, Singh R, Joshi SR, Misra A. Mucormycosis in COVID-19: a systematic review of cases reported worldwide and in India. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2021:9
6. Spielman DB, Gudis DA. Preoperative sinus computed tomography scan review checklist. The Laryngoscope. 2020 Dec;130(12):E706-8.
7. Som PM. Tumors and tumorlike conditions. Head and neck imaging. 2003:289-90.
8. Aygun N, Zinreich SJ. Imaging for functional endoscopic sinus surgery. Otolaryngologic Clinics of North America. 2006 Jun 1;39(3):403-16.
9. Beale TJ, Madani G, Morley SJ. Imaging of the paranasal sinuses and nasal cavity: normal anatomy and clinically relevant anatomical variants. InSeminars in Ultrasound, CT and MRI 2009 Feb 1 (Vol. 30, No. 1, pp. 2-16). WB Saunders.
10. Lloyd GA, Lund VJ, Scadding GK. CT of the paranasal sinuses and functional endoscopic surgery: a critical analysis of 100 symptomatic patients. The Journal of Laryngology & Otology. 1991 Mar;105(3):181-5.
11. Dammann F. Imaging of paranasal sinuses today. Der Radiologe. 2007 Jul 1;47(7):576-8.
12. Chakraborty P, Ragni J. Radiologic variations of nose and paranasal sinuses: A CT based study. J Med Sci Clin Res. 2016;4:10536-41.
13. Kanwar SS, Mital M, Gupta PK, Saran S, Parashar N, Singh A. Evaluation of paranasal sinus diseases by computed tomography and its histopathological correlation. Journal of Oral and Maxillofacial Radiology. 2017 May 1;5(2):46.
14. Kushwaha SK, Keshari RK, Rai AK. Advances in nasal trans-mucosal drug delivery. Journal of applied pharmaceutical science. 2011 ;1(7):21.
15. Zinreich SJ. Imaging for staging of rhinosinusitis. Annals of Otology, Rhinology & Laryngology. 2004;113(5_suppl):19-23.