Research Article

Computed tomography of paranasal sinuses for early and proper diagnosis of nasal and sinus pathology

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ABSTRACT

Background: Pathological lesions of the paranasal sinuses include a wide spectrum of conditions ranging from inflammation to neoplasms both benign and malignant. Most patient of common cold present with symptoms of nasal discharge, nasal obstruction, headache and nasal allergy etc. The patient of paranasal mass usually present with facial deformity, swelling or repeated episodes of epistaxis. The aim of the study was to establish the role of CT in evaluation of pathologies and their proper early diagnosis.
Methods: It is a prospective study. A total of 100 patients who were referred to our department with clinical suspicion of PNS disease underwent CT evaluation of PNS using 64 multi slice CT scanner from December 2012 to October 2015.
Results: Out of 100 cases 51 (51%) cases were males and rest 49 (49%) patients were females. The majority of the cases were of age group 16-30 which were 37case (37%) The most common symptoms were nasal obstruction (50%), followed by nasal discharge (49%), headache in 20% cases. Most common anatomical variations seen was deviated nasal septum (49%) more commonly on right side next common was agger nasi in 48% of cases. Maxillary sinuses are most commonly involved in the study (82 cases), followed by the ethmoid sinuses (ant. group 77 cases, post group 40 case) and frontal sinus 55 cases. The most common pathology seen was masses in 30% cases followed by DNS in 21% cases. The most common form of mucosal thickening noted is circumferential type seen in 7% cases. The most common pathology involving the sinuses was sinusitis (30%) followed by polyp (25%).
Conclusions: Most of the patients with PNS pathology were from 2nd and 3rd decade. Slight male preponderance was noted. Majority of the patients presented with nasal obstruction. Most common anatomical variant seen was DNS. Most common sinus involved was maxillary. Sinonasal pathologies were the most common followed by pure nasal or pure sinosal. The most common pathology was inflammatory (74%). The most common benign pathologies were polyps with 92% accuracy. 15% of cases had malignancy with diagnostic accuracy of 90%.

Keywords: CT-PNS, Rhinosinusitis, Sino-nasal diseases

INTRODUCTION

Pathological lesions of the paranasal sinuses include a wide spectrum of conditions ranging from inflammation to neoplasms both benign and malignant. Most patient of common cold present with symptoms of nasal discharge, nasal obstruction, headache and nasal allergy etc. The patient of paranasal mass usually present with facial deformity, swelling or repeated episodes of epistaxis. Preliminary investigation by standard sinus radiographs are sub optimal in displaying regional morphology of ostiomeatal area, ethmoid and sphenoid sinuses and anatomical variants. Further there is overlapping between

these structures hence these are insufficient to diagnose and as a guide to endoscopic sinus surgery and modified PNS surgeries.

Computed tomography (CT) has shown enormous development since the original CT images obtained by Hounsfield in early 1970. CT has been revolutionised by utilizing differential contrast enhancement characteristics of lesion, a clear distinction between tumor mass and inflammatory tissue can be made out which is of utmost importance for treatment of patients. CT also plays role in diagnosing the complications and intracranial extension of sinonasal diseases.

The CT scan proved to be an excellent imaging tool as it can accurately diagnose and differentiate benign and malignant lesions, can describe the masses in terms of their origin, nature, extension, and involvement. Now with the unique ability of CT to image the bones and soft tissues, direct coronal scanning and sagittal reconstruction imaging the space occupying lesions. By acting as a roadmap preoperative CT scan PNS has proved to reduce the post-operative complications of FESS and other surgeries.

The multifaceted benefits of CT in PNS over other imaging and diagnostic procedures are countless. The present study was conducted to establish the role of CT in evaluation of pathologies and their proper early diagnosis.

METHODS

This prospective study was done in the Department of otorhinolaryngology of Mahatma Gandhi Memorial Medical College & M.Y. Hospital, Indore, Madhya Pradesh, India. A total of 100 patients who were referred to our department with clinical suspicion of PNS disease underwent CT evaluation of PNS using 64 Multi slice CT scanner from December 2012 to October 2015.

Study protocol

A detailed history of the patient including signs and symptoms, detailed physical examination, biochemical investigations and radiological investigations which included PNS X-ray were recorded and tabulated. A written consent was taken. Iodinated IV contrast agent is given if required. The patient was then placed on the gantry table in prone position. The coronal scan is taken from posterior margin of sphenoid sinus to anterior margin of frontal sinus and rest of the planes are reconstructed from it.

RESULTS

The present study was conducted in a study population of 100 patients, who presented with clinical complaints of nasal obstruction, nasal discharge and positive ENT examination findings and underwent computed tomographic imaging. The computed tomographic imaging was then evaluated to identify the abnormalities in our study group.
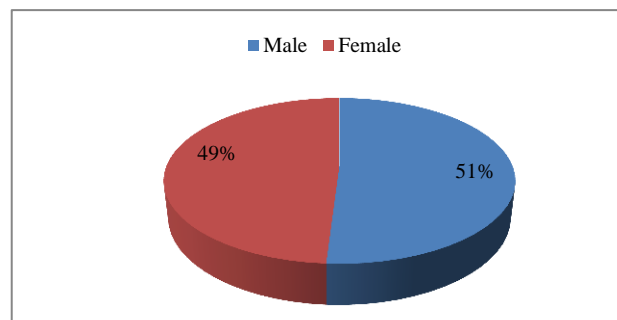

Figure 1: Classification of cases on the basis of their sex.

Out of 100 cases 51 (51%) cases were males and rest 49 (49%) patients were females (Figure 1).

Table 1: Classification of cases on the basis of their age and sex.

Age group (years)	Male	Female	Total no. of cases	Percentage
<15	7	6	13	13%
16-30	20	17	37	37%
31-45	13	17	30	30%
46-60	8	7	15	15%
>60	3	2	5	5%
Total	51	49	100	100%

The majority of the cases were of age group 16-30 which were 37 cases (37%), 30 cases (30%) in age group 31-45 years, 15 cases (15%) in age group 46-60 years. 13 cases (13%) below 15 years. and 5 cases (5%) more than 60 years age group (Table 1).

Table 2: Classification of cases on the basis of their presenting complaints.

Symptom	No. of cases	Percentage
Nasal obstruction	50	50%
Nasal discharge	49	49%
Headache	20	20%
Face swelling	17	17%
Allergy	8	8%
Epistaxis	5	5%
Proptosis	4	4%
Loss of vision	1	1%

The most common symptoms were nasal obstruction (50%), followed by nasal discharge (49%), headache in 20% cases (Table 2).

Most common anatomical variations seen was deviated nasal septum (49%) more commonly on right side next common was agger nasi in 48% of cases (Figure 2).
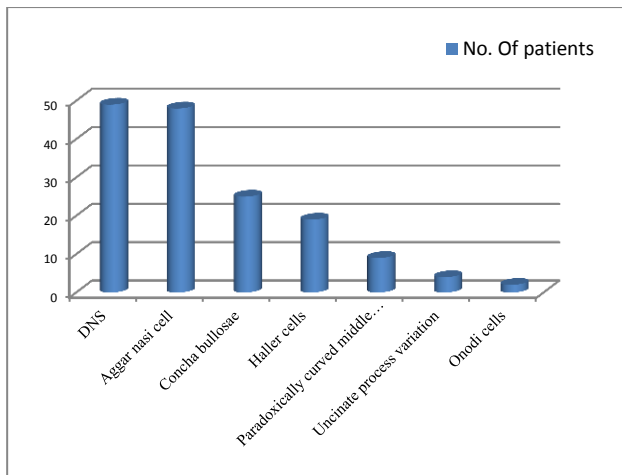
Figure 2: Classification of cases on the basis of anatomical variants of PNS.

Maxillary sinuses are most commonly involved in the study (82 cases), followed by the ethmoid sinuses (ant. group 77cases, post group 40 case) and frontal sinus 55 cases (Figure 3).
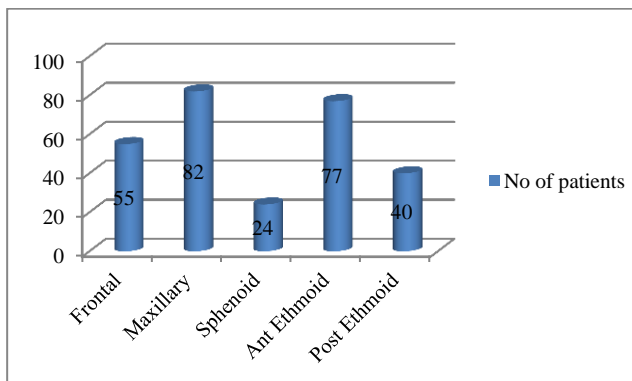

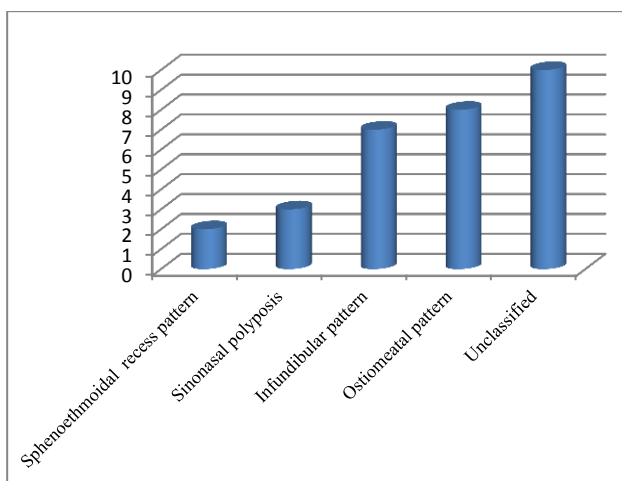**Figure 3: CT findings in paranasal pathologies.**

Figure 4: Classification of cases on the basis of radiological pattern of rhinosinusitis.

The most common radiological pattern of sinus involvement is unclassified type seen in 33% of cases, followed by ostiomeatal pattern in 26% (Figure 4).

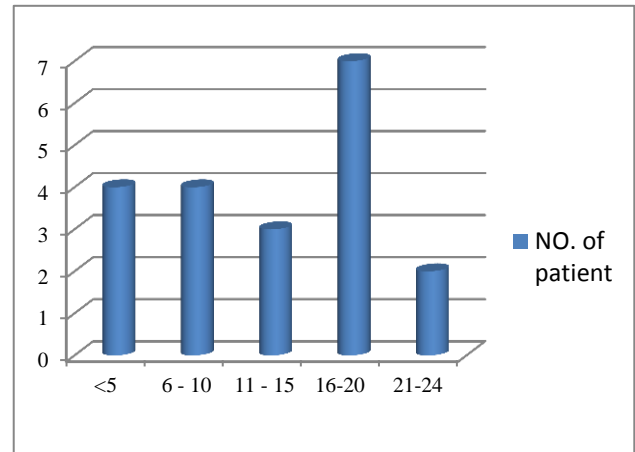Most of the patients have score between 16-20 (35%) (Figure 5).

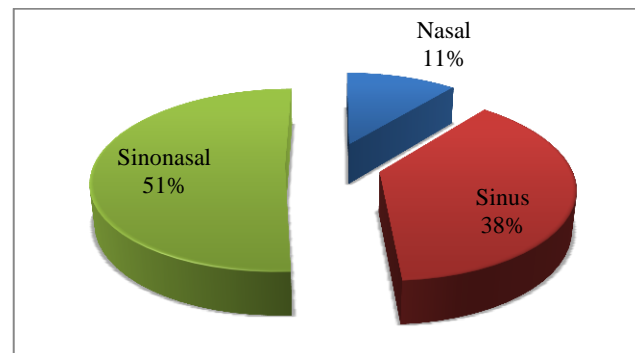**Figure 5: Classification of cases on the basis of Lund-Mackay score.**

Figure 6: Classification of cases on the basis of type of pathology.

The most common pathologies are sinonasal (51%) followed by sinus involvement in 38% cases (Figure 6).
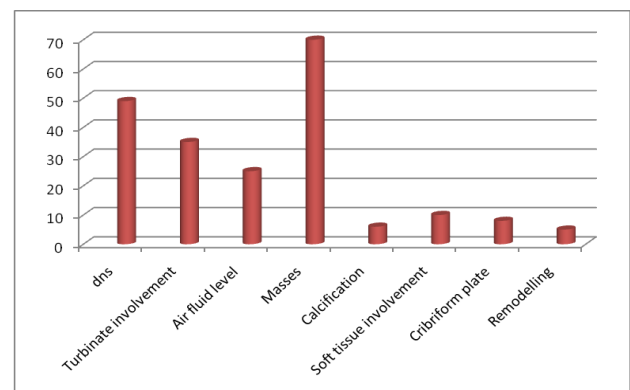

Figure 7A: Classification of cases on the basis of CT features.

The most common pathology seen was Masses in 30% cases followed by DNS in 21% cases. The most common form of mucosal thickening noted is circumferential type seen in 7% cases. Cases are distributed on the basis of bony involvement (Figure 7A and B).
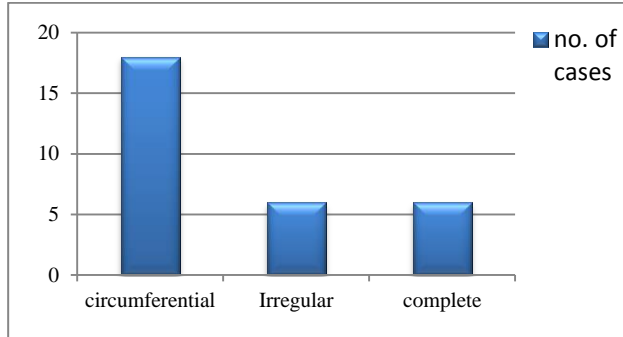

Figure 7B: Classification of mucosal thickening cases on the basis of CT features.

The most common form of metastasis seen is soft tissue involvement (33%) followed by intracranial (22%) and infratemporal (22%) region (Figure 8).
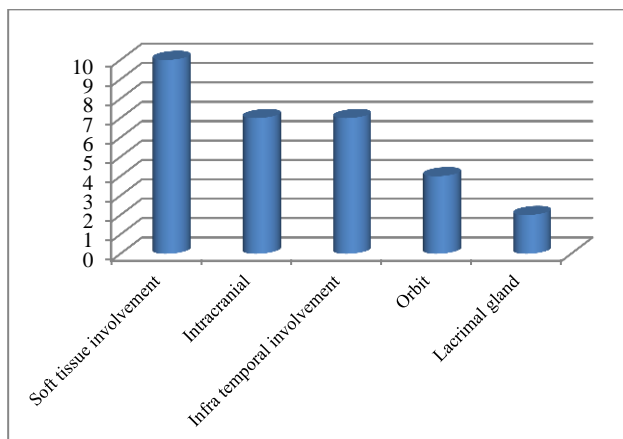

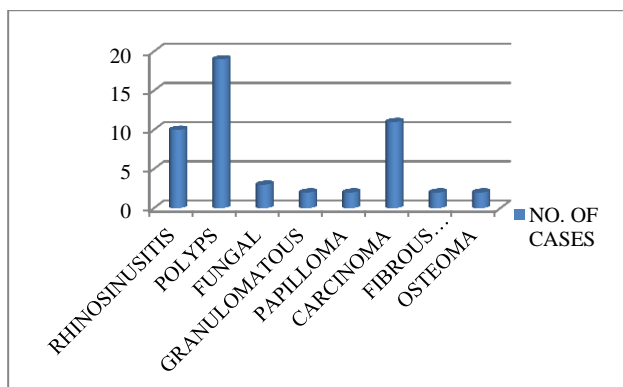**Figure 8: Classification on the basis of extension of disease.**

Figure 9: Classification of cases on the basis of sinonasal pathologies.

The most common pathology involving sinonasal region is polyp (37%) followed by carcinoma (21%) (Figure 9).

The most common Nasal pathology noted was angiofibroma (28%) followed by carcinoma (18%) (Figure 10).
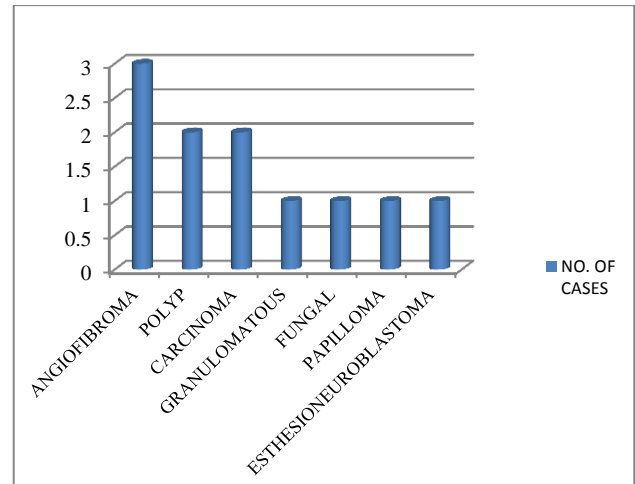
Figure 10: Classification of cases on the basis of nasal pathologies.

The most common pathology involving the sinuses was sinusitis (30%) followed by polyp (25%) (Figure 11).
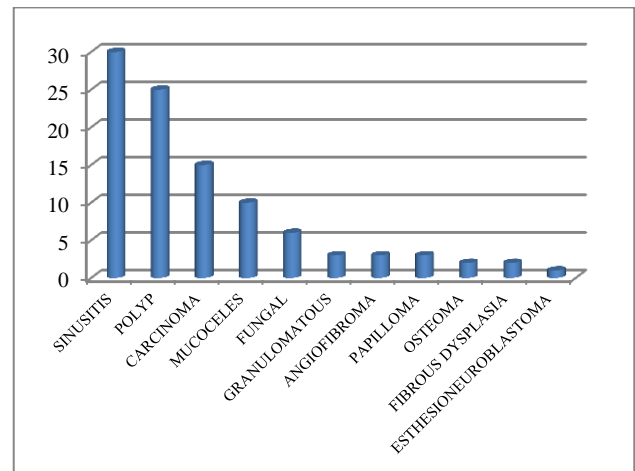
Figure 11: Classification of cases on the basis of all pathologies.

DISCUSSION

Computed tomography plays an indispensable role in the detection and characterization of paranasal sinus pathologies. The characterisation of PNS lesions is of immense importance because the identifying abnormalities of PNS influence the clinical and surgical decision making. Our study was carried out in the department of otorhinolaryngology and head and neck surgery, Mahatma Gandhi Memorial medical college and

Maharaja Yeshwant Rao group of Hospitals, Indore, Madhya Pradesh, India. It included 100 patients having PNS pathology who underwent CT. The majority of the cases in our study were of the age group 16 - 30 years (37%) followed by 31-45 years (30%), 46-60 years (15%) below 15 years (13%) and age group above 60 years (5%).

In our study, 51% of the cases were male while 49% were female with marginal preponderance for male which is in concordance with study conducted by Nitin VD et al.[1] Patients presented with overlapping symptoms in most cases, of which the most common presenting complain being nasal obstruction (50%) followed by nasal discharge (49%), which is consistent with the study conducted by Gautam P et al.[2]

In our study, the most common PNS pathology was sinusitis, it is classified as bacterial, viral, fungal; acute, or chronic sinusitis and based on region involved sinonasal or purely nasal or sinosal. In our study the most common pattern of involvement was sinonasal (51%) with maxillary sinus being the most common sinus involved (82%) followed by posterior ethmoidal (77%), which is consistent with the study done by Bolger et al.[3] There are 5 basic pattern of mucosal involvement seen in patients of chronic sinusitis chronic sinusitis they are, infundibular , osteomeatal unit , sphenoethmoidal recess, sinonasal polyposis and unclassified. Most common pattern in our study was unclassified (33%) followed by osteomeatal unit pattern (26%), infundibular pattern (24%), sinonasal polyposis (10%), sphenoethmoidal recess pattern (7%). The findings are consistent with the study done by Naimi et al.[4]

According to Lund-Mackey grading b/l sinuses were graded subjectively based on opacification 0- no opacification, 1- partial opacification, 2- total opacification. Osteo meatal unit is graded as 0 or 2.Total score is 24. Mean lund score in disease positive cases are 9.8 and in control group 4.9. In our study most of the cases diagnosed as chronic rhinusinusitis have the score between16-20 (35%) and minimum has the score between 21-24 (10%). The findings are consistent with the study done by Silberstein S et al.[5] On the basis of mucosal thickening most common pattern noted is circumferential (7%) followed by irregular (2%).This finding is supported by Carmeli G et al.[6]

Fungal sinusitis is a chronic form of inflammation which shows complete opacification of sinus, bony erosion, and calcification with involved sinus showing higher attenuation than bacterial sinusitis. In our study 6 patients had fungal sinusitis, of which nasal involvement was seen in 16% and bony erosion and calcification seen in 30% and 50% respectively. This is in consistency with study done by Huan J et al.[7]

Antrochoanal polyp is an inflammatory growth with bone remodelling and sinonasal involvement. In our study 25cases were diagnosed as antrochoanal polyp in which sinonasal involvement was seen in 76% and 10% shows bone remodelling. On follow up 2 cases were diagnosed as rhinosinusitis. So the diagnostic accuracy for polyp in our study was 92% which is consistent with the study done by Gupta et al.[8]

Mucocele is an expansile, cystic, hypo to isodense lesion with bony erosion and intraorbital extension with no contrast enhancement. In our study frontal sinus was the most common sinus involved (80%). 10% cases showed orbital extension and 20% showed bony erosion, this is consistent with study done by Beratriz peral et al. Diagnostic accuracy of mucocele in our study was 100% which is consistent with the study done by Silberstein et al.[5]

Granulomatous disease is characterised by mucosal thickening, bony sclerosis and calcification. In our study 3 cases were diagnosed as granulomatous disease. 2 out of 3 were sinonasal and 1 was purely nasal. The diagnostic accuracy in our study is 100% which is in concordance with study done by Bakshi J et al.[9]

Angiofibroma is locally invasive neoplasm arising from pterygopalatine fossa causing progressive destruction of surrounding structures, bony erosion and show homogenous enhancement on CECT. In our study 3 cases were diagnosed angiofibroma all of which showed involvement of the pterygopalatine fossa, bony erosion was seen in 70% and sinus involvement in 33% of cases. The diagnostic accuracy in our study is 100% and is consistent with the study of Kosling et al.[10]

Papilloma is primary benign lesion of nasal cavity and paranasal sinuses, which showed mass in the nasal cavity with opacification of sinus and bony erosion. In our study maxillary sinus was the most commonly involved (66%) sinus. On follow up, 1 case turned out to be antrochoanal polyp. So the diagnostic accuracy in our study is 66%, as seen in the study by Mishra DK et al.[11]

Carcinoma is seen as ill-defined mass lesion with soft tissue involvement, bony erosion and ± intracranial spread. In our study 15 patients were diagnosed as carcinoma, all of these patients had mass, 90% showed bony erosion with 20% having intracranial extension. On follow up 1 case was diagnosed as lymphoma. So the diagnostic accuracy for carcinoma in our study was 90%. The observation is similar to study done by Lenz M et al.[12]

Esthesioneuroblastoma is a uniformly enhancing soft tissue mass in the nasal cavity with bony erosion and also having intracranial extension. In our study esthesioneuroblastoma was diagnosed with 100% accuracy finding is similar to the study done by Saleem et al.[13] Osteomas are benign slow growing tumors with well circumscribed margins and bony erosion/remodelling. In our study 2 cases of frontal sinus osteoma were

diagnosed. The diagnostic accuracy was 100% which is similar to the study done by Sabarawal KK et al.[14]

Fibrous dysplasia is seen as hyperdense heterogenous, expansile mass of uneven contour involving the bone of the sinus with a typical aspect of "opaque glass" appearance. In our study 2 cases of fibrous dysplasia of maxillary sinus were diagnosed. The diagnostic accuracy being 100% in our study, which is similar to that seen in study by Shulte M et al. Kim HJ et al in 2004 studied the precise anatomy and anatomical variations of the nose, as well as the relationship between such anatomy and chronic sinusitis. They concluded that anatomical variations in the nose and paranasal sinuses are common in children. Panchal L et al in 2004, did retrospective study in 69 patients to rule out the incidence, mode of presentation and histological types of sino-nasal epithelial tumors in the surgical pathology material. They concluded that sinonasal epithelial tumors are rare lesions,with male prepodance. Inverted papillomas and squamous cell carcinoma are the most frequent neoplasms.

Kaplan BA et al determine the diagnostic criteria and etiology of complete unilateral maxillary sinus opacification and found that unilateral maxillary sinus opacification is a relatively common finding.[15] Early identification of inverting papillomas and mucoceles may avoid delay in surgical intervention, whereas acute/chronic rhinosinusitis and nasal polyposis can initially be managed medically. Careful history, endoscopic examination, and radiographic studies can often determine the responsible disease process. Dua K et al comment that CT Scan Paranasal sinuses has become mandatory for all patients undergoing functional endoscopic sinus surgery.[16] It depicts the anatomical complexities of ostiomeatal complex in much simpler way and acts as a road map for endoscopic sinus surgery. Fifty patients of chronic sinusitis were evaluated by CT Scan PNS -coronal and axial views. The anatomical variations and changes in osteomeatal complex on CT Scanwere studied. In majority of patients, osteomeatal complex and anterior ethmoids were involved (88%). Agger nasi cells (40%) were the most common anatomical variations followed by concha bullosa and hallercells (16%). Apart from this deviated nasal septum was found in 44% of patient.

Sinus computed tomography (CT) is widely performed in the imaging workup of sinusitis, but it is sometimes criticized by the surgeons for its lack of specificity. There have been studies where mucosal thickening of the paranasal sinus has been seen in up to 30% of the asymptomatic population. Rak KM et al.[17] In addition to that ,the mucosal thickening of sinuses has been reported in patients with nonspecific upper respiratory tract infection, such as the common cold and coryza. Gwaltney Jr et al there have been numerous reports in surgical journals that found sinus CT findings did not correlate well with a patient's clinical symptoms, since results of sinus CT can be normal for severely symptomatic patients and abnormal for patients with minimal symptoms Anzai Y et al.[18,19]

Shwartz R 2010 describes CT findings in primary nasal and nasopharyngeal rhinoscleroma include soft-tissue masses of variable sizes. The lesions are characteristically homogeneous and nonenhancing, and they have distinct edge definition. Adjacent fascial planes are not invaded. Findings also include calcifications, luminal stenosis, wall thickening, and nodules. The diagnostic accuracy using above CT criteria for different lesions was assessed. The CT accuracy for inflammatory lesions in our study was 86%, for benign lesion was 90% and 80% for malignant lesions. Thus CT had a high accuracy, sensitivity and specificity for differentiating and characterisation of inflammatory, benign and malignant lesions of PNS.

CONCLUSION

The present study was undertaken to determine the role of CT in evaluation of PNS pathology and its potential role in differentiating benign from malignant lesion. 100 patients with complains of PNS pathology were imaged. The CT characteristics of pathology were evaluated. From the observations we concluded that Most of the patients with PNS pathology were from 2nd and 3rd decade. Slight male preponderance was noted. Majority of the patients presented with nasal obstruction. Most common anatomical variant seen was DNS. Most common sinus involved was maxillary. Sinonasal pathologies were the most common followed by pure nasal or pure sinosal. The most common pathology was inflammatory (74%). The most common benign pathologies were polyps with 92% accuracy. 15% of cases had malignancy with diagnostic accuracy of 90%. Computed tomography has high accuracy, sensitivity and specificity for detection, characterisation and differentiation of inflammatory, benign and malignant lesions of PNS.

REFERENCES

1. Deosthale NV, Singh B, Khadakkar SP, Harkare VV, Dhoke PR, Dhote KS, et al. Effectiveness of Nasal Endoscopy and C.T. Scan of Nose and Paranasal Sinuses in Diagnosing Sino-Nasal Conditions. Journal of Evolution of Medical and Dental Sciences. 2014;3(14):3695-703.
2. Gautam P, Modwal A, Saboo RA. Comparative Study of CT scan PNS with nasal endoscopy findings in chronic rhino sinusitis patients. Transworld Medical Journal. 2014;2(1):14-7.

3. Bolger WE, Butzin CA, Parson DS. Paranasal sinus bony analysis for endoscopic sinus surgery. Laryngoscope. 1991;101:56-64.
4. Naimi M, Bakhshaei M. The major obstructive inflammatory pattern of sinonasal disease in 200 candidates of FESS. IJR. 2006;17(42):9-16.
5. Silberstein S. Headaches due to nasal and paranasal sinus disease. Neurol Clin. 2004;22:1-19.
6. Carmeli G, Artzi Z, Kozlovsky A, Segev Y, Landsberg R. Antral computerized tomography pre-operative evaluation: Relationship between mucosal thickening and maxillary sinus function. Clin Oral Implants Res. 2011;22:78-82.
7. Yoon JH, Na DG, Byun HS, Koh YH, Chung SK, Dong HJ. Calcification in chronic maxillary sinusitis: comparison of CT findings with histopathologic results. AJNR Am J Neuroradiol. 1999;20(4):571-4.
8. Gupta SC, Singh M, Jain A, Walia DK. A comparative study of radiological and antroscopic findings in the lesions of maxillary sinus. Indian Journal of Otolaryngology and Head and Neck Surgery. 2004;56(1).
9. Bakshi J, Venables PJ, Abraham S. Sinonasal sarcoid. Journal of Postgraduate Medicine. 2009;55(1):43-4.
10. Kosling S, Wanger F, Schulz HG, Heywang KS. Osseous variations in coronary CT of the PNS. Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr. 1993;159(6):506-10.
11. Mishra D, Rajeev S, Saxena R. A study on the clinical profile and management of inverted papilloma. Internet Journal of Otorhinolaryngology. 2009;10(2): 1-6.
12. Martin LM. CT & MR of head and neck tumor 1993, Thieme medical publication page 65-98.
13. Niazi SA, Saeedullah. Olfactory neuroblastoma presenting as bleeding polyp. J Ayub Med Coll Abbottabad. 2012;24(3-4):208-9.
14. Sabharwal KK, Chouhan AL, Jain S. CT evaluation of proptosis. Indian J Radiol Imaging [serial online] 2006;16(4):683-8.
15. Kaplan BA, Kountakis SE. Diagnosis and pathology of unilateral maxillary sinus opacification with or without evidence of contra lateral disease; Laryngoscope. 2004;114(6):981-5.
16. Dua K, Chopra H, Khurana AS, Munjal M. CT scan variation in chronic sinusitis. Indian J radio. 2005 15(3):315-20.
17. Rak KM, Newell II JD, Yakes WF, Damiano MA, Luethke JM. Paranasal sinuses on MR images of the brain: significance of mucosal thickening. AJR Am J Roentgenol.1991;156:381-4.
18. Gwaltney Jr JM, Phillips CD, Miller RD, Riker DK. Computed tomographic study of the common cold. N Engl J Med.1994;330:25-30.
19. Anzai Y, Weymuller, Jr EA, Yueh B, Maronian N, Jarvik JG. The Impact of sinus computed tomography on treatment decisions for chronic sinusitis. Arch Otolaryngol Head Neck Surg. 2004;130(4):423-8.