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Evaluation of paranasal sinus diseases by computed tomography: A tertiary care hospital based study

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ABSTRACT

Background: Paranasal sinus (PNS) diseases affect a wide range of population and include a broad spectrum of diseases ranging from inflammatory conditions to neoplasms, both benign and malignant. The application of computed tomography (CT) in the paranasal sinuses study has allowed the detail assessment of inflammation, cysts, benign, and malignant conditions. CT has increased the accuracy of patient management with a consequent decrease in morbidity and mortality. **Materials & Methods:** This hospital based prospective study was carried out in Department of ENT and Radio diagnosis of a tertiary care teaching hospital, Haldia, West Bengal from January 2018 to March 2019. Institutional Ethical Approval was obtained for the study. A total of 44 patients fulfilling the inclusion criteria, were included in the present study. The CT was done using Philips 16 Slice BRILLIANCE 190P MDCT and images were acquired in both axial and coronal planes. Post contrast study was done in those who required further evaluation. Soft tissue window level and width (50/200) and bone window level and width (350/2500). Contrast agent Omnipaque 350 was used if indicated and consent was obtained from the patient. CT findings were evaluated in all the patients and characterisation of the various sinonasal lesions were done with the help of various CT parameters. **Results:** Our study included 30 males (68.18%) and 14 females (31.82%)) aged between 4 yrs and 78 years, as all the patients with suspected sinonasal pathologies presented during the specified period of study were included without taking age as criteria for exclusion. Most common sinonasal pathology in present study was chronic sinusitis (other than fungal) 19 (43.18%) followed by sinonasal polyps 11 (25%) and antrochoanal polyp 5 (11.36%). Only 2 cases out of 44 (4.54%) sinonasal pathologies diagnosed to be malignant lesions on CT findings. The chief presenting complaints were of a headache (70.45%) followed by nasal discharge (43.2%), nasal obstruction (47.73%), facial pain (38.64%), allergic symptoms (15.91%), hyposmia (11.36%), epitaxis (6.82%), and mouth breathing (20.45%). **Conclusion:** CT is considered the gold standard for preoperative evaluation of PNS diseases for appropriate patient selection for functional endoscopic sinus surgery. CT of the sinuses uses special x-ray equipment to evaluate the paranasal sinus cavities – hollow, air-filled spaces within the bones of the face surrounding the nasal cavity.

Key words: Paranasal sinus (PNS) diseases, Computed tomography (CT), Inflammatory, Neoplastic.

INTRODUCTION

The nasal passage and paranasal sinuses plays host to a wide spectrum of diseases and conditions which can be collectively termed as sinonasal disease. Paranasal sinuses (PNSs) diseases commonly affect the varied range of population, which range from inflammatory conditions to neoplasms, both benign and malignant[1]. Plain film is inaccurate and inadequate in the diagnosis of non-neoplastic and neoplastic conditions of PNS. Imaging of the PNS has progressed from the realm of conventional radiographs (plain films) almost exclusively into the realms of CT. Technological

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advances in these two imaging modalities have provided more precise differential diagnosis and details about the anatomic extent of the diseases of PNS. These provide sufficient information for diagnosis and surgical planning in the PNS diseases[2]. A CT scan is one of the safest means of studying the sinuses. CT is the most reliable imaging technique for determining if the sinuses are obstructed. It is the best imaging modality for sinusitis. CT of the sinuses can help plan the safest and most effective surgery. CT of the sinuses is now widely available and is performed in a relatively short time, especially when compared to magnetic resonance imaging (MRI). CT scanning is painless, noninvasive and accurate. A major advantage of CT is its ability to image bone, soft tissue and blood vessels all at the same time. Unlike conventional x-rays, CT scanning provides very detailed images of many types of tissue as well as the lungs, bones, and blood vessels.[3-5] CT determines the distribution and extent of disease and detects those anatomic variations[6] (like septal deviation, spur formation, concha bullosa, paradoxical; curve of middle turbinate etc.) that may place the patients at increased risk for intra operative and post operative FESS complications and there by reduces morbidity and mortality of patients[7]. Concha bullosa (also known as middle turbinate pneumatization) is a common finding and although associated with deviation of the nasal septum, it is usually of little clinical importance[8].Concha bullosa is a common anatomic variant. There is a strong association between the presence of a concha bullosa and contralateral deviation of the nasal septum. Nasal septal deviation away from the dominant concha, with preserved adjacent air channels, suggests that the deviation is not a direct result of mass effect from the concha. No increased incidence of paranasal sinus disease exists in patients with concha bullosa[9].The ostiomeatal complex (OMC) or ostiomeatal unit (OMU), is a common channel that links the frontal sinus, anterior ethmoid air cells and the maxillary sinus to the middle meatus, allowing airflow and mucociliary drainage[10]. This study was done to determine the role and efficacy of CT scan in diseases of paranasal sinus and study of various physiological variants.

MATERIALS AND METHODS

This hospital based prospective study was carried out in Department of ENT and Radio diagnosis of a tertiary care teaching hospital, Haldia, West Bengal from January 2018 to March 2019. Institutional Ethical Approval was obtained for the study. A total of 44 patients fulfilling the inclusion criteria, were included in the present study. A descriptive analysis of imaging findings was conducted, tabulated, and results were derived. The CT was done using Philips 16 Slice BRILLIANCE 190P MDCT and images were acquired in both axial and coronal planes. Post contrast study was done in those who required further evaluation. Patient position was supine for axial and coronal sections. Slice thickness for axial and coronal planes was 3mm and inter-space was 3mm, exposure factors used were 120kvp and 60 mAs. Scan time was 1.5sec. Soft tissue window level and width (50/200) and bone window level and width (350/2500). Contrast agent Omnipaque 350 was used if indicated and consent was obtained from the patient. CT findings were evaluated in all the patients and characterisation of the various sinonasal lesions were done with the help of various CT parameters. Final imaging diagnosis correlated with histopathological confirmation or treatment response.

RESULTS

A total of 44 patients fulfilling the inclusion criteria, were included in the present study. A descriptive analysis of imaging findings was conducted, tabulated, and results were derived. CT findings were evaluated in all the patients and characterisation of the various sinonasal lesions were done with the help of various CT parameters.

Table 1: Age and sex distribution of various sinonasal lesions

Age in years	Number (N=44)			Percentage
	Male	Female	Total	
0-10	1 (2.27%)	0	1	2.27%
11-20	5 (11.36%)	2 (4.54%)	7	15.91%
21-30	9 (20.45%)	4 (9.09%)	13	29.54%
31-40	6 (13.64%)	3 (6.82%)	9	20.45%
41-50	4 (9.09%)	2 (4.54%)	6	13.64%
51-60	2 (4.54%)	2 (4.54%)	4	9.09%
61-70	2 (4.54%)	0	2	4.54%
>70	1 (2.27%)	1 (2.27%)	2	4.54%

Total	30 (68.18%)	14 (31.82%)	44	100%

Our study included 30 males (68.18%) and 14 females (31.82%)) aged between 4 yrs and 78 years, as all the patients with suspected sinonasal pathologies presented during the specified period of study were included without taking age as criteria for exclusion. The majority of the cases were in the age group of 21–30 years (29.54%) and least number of patients was in age group of 0-10 years (2.27%). The youngest patient was 4-years-old, and eldest patient was 78-years-old. There was a male predominance of 68.18% (30/44) as compared to females 31.82% (14/44). The male to female ratio was 2.14:1 [Table 1].

Table 2: Etiopathological distribution of cases on the basis of CT parameters (N=44)

Diagnosis	No. of Cases [Percentage]
Chronic Sinusitis (other than fungal)	19 (43.18%)
Sinonasal polyps	11 (25%)
Antrochoanal polyp	5 (11.36%)
Fungal sinusitis	3 (6.82%)
Neoplastic	2 (4.54%)
Mucocele	1 (2.27%)
Rhinoscleroma	2 (4.54%)
Miscellaneous	1 (2.27%)
Total	44 (100%)

The various sinonasal pathologies diagnosed on CT are classified based on their imaging features. Most common sinonasal pathology in present study was chronic sinusitis (other than fungal) 19 (43.18%) followed by sinonasal polyps 11 (25%) and antrochoanal polyp 5 (11.36%). Only 2 cases out of 44 (4.54%) sinonasal pathologies diagnosed to be malignant lesions on CT findings [Table 2].

Table 3: Clinical features distribution of various sinonasal pathologies (N=44)

Clinical features	No. of Cases [Percentage]
Headache	31 (70.45%)
Nasal Discharge	19 (43.2%)
Nasal Obstruction	21 (47.73%)
Facial Pain	16 (38.64%)
Allergic Symptoms	7 (15.91%)
Hyposmia	5 (11.36%)
Epistaxis	3 (6.82%)
Mouth Breathing	9 (20.45%)
Maxillary Sinus	34 (77.27%)
Ethmoid Sinus Anterior Posterior	 23 (52.27%) 19 (43.18%)
Sphenoid Sinus	9 (20.54%)
Frontal Sinus	16 (36.36%)
DNS Right sided	19 (43.18%)
Left sided	14 (31.82%)
Bilateral	6 (13.63%)
Concha bullosa Left sided Right sided Bilateral	15 (34.09%) 7 (15.9%) 5 (11.36%) 3 (8.33%).
Ostiomeatal unit obstruction Left sided Right sided Bilateral	26 (59.09%) 11 (25%), 13 (29.5%) 2 (4.5%)

The chief presenting complaints were of a headache (70.45%) followed by nasal discharge (43.2%), nasal obstruction (47.73%), facial pain (38.64%), allergic symptoms (15.91%), hyposmia (11.36%), epitaxis (6.82%), and mouth breathing (20.45%). Maxillary sinuses were most commonly involved in the study

77.27% cases, followed by anterior ethmoid sinus 52.27%, posterior ethmoid 43.18%, frontal sinus involvement 36.36% and sphenoid sinus involvement in 20.54% cases [Table 3]. DNS was noted toward right side in 43.18% cases and toward left side in 31.82% of cases. Concha bullosa was noted in 15 (34.09%) cases of which left sided involvement was noted in 7 (15.9%), right sided in 5 (11.36%) and bilateral in 3 cases (8.33%). Ostiomeatal unit (OMU) obstruction was noted in 26 cases (59.09%), of which left sided was noted in 11 (25%), right sided in 13 (29.5%), and bilateral involvement was seen in 2 (4.5%) cases. The most common pattern of involvement was sinonasal polyposis 11 (25%), followed by osteomeatal 7 (15.9%), infundibular 5 (11.36%), sphenoethmoidal recess 2 (4.5%), and sporadic pattern 1 (2.27%) [Table 3].

Table 4: Sinuses involved in various pathologies [n=44]

Sinus involved	Inflammatory	Neoplastic			Miscellaneous
		Benign	Malignant	Total	
Maxillary Sinus	23(52.27%)	9(20.54%)	2 (4.54%)	34(77.27%)	0
Ethmoid Sinus	18(40.9%)	5(11.36%)	0	23(52.27%)	0
Sphenoid Sinus	6 (13.63%)	2 (4.54%)	0	9(20.54%)	1 (2.27%)
Frontal Sinus	13 (29.5%)	3 (6.82%)	0	16(36.36%)	0

The etiologic distribution of the lesions was inflammatory (50%), neoplastic benign or malignant (47.7%), and miscellaneous (2.27%). Thus, the inflammatory disease was found to be the most frequently occurring pathology affecting the PNS [Table 4, Figure 1 & 2].

Table 5: CT features of benign and malignant neoplasms

CT parameter	Benign (*n*=19) (%)	Malignant (*n*=2) (%)
Sinus size increased	14 (73.68 %)	2 (100%)
Erosions	6 (31.58%)	2 (100%)
Thinning	3 (15.79%)	2 (100%)
Sclerosis	1 (5.26%)	1 (50%)
Extensions in at least one region	4 (21.05%)	2 (100%)

In the present study, 21 cases were diagnosed to have neoplastic lesions, in which 19 were benign and 02 were malignant cases. In the present study, bony erosion was seen in all the 2 (100%) malignant masses and thus found to be most valuable CT criteria for the diagnosis of malignancy. However, 6 (31.58%) of benign neoplasms also showed bone erosions (Table 5). In 100% of malignant neoplasms extension to one of the adjacent regions was present, compared to 21.05% in benign neoplasms. Rests of the criteria like increase in size of the sinus (73.68 %), thinning of walls (15.79%), sclerosis (5.26%) in benign lesions also did differed much from malignant masses [Table 5].

DISCUSSION

The radiological evaluation of sinonasal diseases is very essential as the clinical findings in these cases may be non-specific[11]. Available imaging techniques include plain radiography, CT, Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET). Our study showed the majority of the cases were in the age group of 21–30 years (29.54%) and least number of patients was in age group of 0-10 years (2.27%). The youngest patient was 4-years-old, and eldest patient was 78-years-old. There was a male predominance of 68.18% (30/44) as compared to females 31.82% (14/44). The male to female ratio was 2.14:1 Prabhu VR et al study revealed majority of cases were females 66% (33). Males accounted for 34% (17) with Female: Male ratio is 1.9:1[12].Present study showed various sinonasal pathologies diagnosed on CT are classified based on their imaging features. Most common sinonasal pathology in present study was chronic sinusitis (other than fungal) 19 (43.18%) followed by sinonasal polyps 11 (25%) and antrochoanal polyp 5 (11.36%). Only 2 cases out of 44 (4.54%) sinonasal pathologies diagnosed to be malignant lesions on CT findings. Kandukuri R et al study revealed most common sinonasal pathology in present study was inflammatory (77.14%) followed by benign neoplastic (12%) and malignant lesions (9.7%)[12]. Prabhu VR et al study revealed 56% of cases had sinusitis, polyp was found in 32%, fungal sinusitis 8%, inverted papilloma 12%. During FESS, 4 patients were found to have bone involvement in form of erosion or destruction, all 4 patients was detected to have bone involvement in CT[12].Khan N et al study showed the incidence of masses in nasal cavity, paranasal sinuses and nasopharynx was 34.3 cases per year[14].Amongst the 240 cases studied, there were

144 cases (60%) of non-neoplastic lesions, 56 cases (23.33%) of benign lesions and 40 cases (16.67%) of malignant lesions. All age groups were involved and the mean ages of presentation with the increasing age were: non-neoplastic (22.5 years), benign tumors (26.8 years) and malignant tumors (35.3 years). The male to female ratio was 1.7:1 for non-neoplastic lesions; 3:1 for benign tumors: and 2.3:1 for malignant lesions. In this study maximum number of cases was present in nasal cavity (65%) followed by paranasal sinuses (20%) and least number of cases involved the nasopharynx (15%)[14]. Dhillon V et al study showed 60 patients underwent CT scan. On the basis of radiology, out of 60 patients, 43 patients (71.66%) were nonneoplastic, 10 patients (16.66%) were benign and 7 patients (11.66%) were malignant[15]. On diagnostic nasal endoscopy, 31 non-neoplastic lesions had bilateral nasal mass, 12 had unilateral nasal mass. Kandukuri R et al study revealed that the most common inflammatory pathology was sinusitis followed by polyps, [13]which was also found in study done by Azzam MA, Salami et al[16]. Sinusitis was also most common in study done by Vijay Prabhu et al.[12], accounting to 56%.

The most common benign pathology was nasopharyngeal angiofibroma which was also seen in study done by Mohammed A. Gomaa et al.[17] The most common malignant pathology was squamous cell carcinoma of maxillary sinus which was also seen in studies done by in Azzam MA. Salami et al. Study[16] and Mohammed A. Gomaa et al[17]. Kanwar SS et al[4] study revealed that the most common CT diagnosis was chronic sinusitis (40/91) followed by polyp (22/91) and fungal sinusitis (16/91). Out of 91 cases sent for histopathology, most common diagnoses were nonspecific inflammation (57.7%) followed by inflammatory polyp (24.1%), antrochoanal polyp (7.6%), fungal sinusitis (6.5%), and poorly differentiated carcinoma (4.3%) cases. High sensitivity, specificity, positive and negative predictive values were noted in all diagnosis except fungal sinusitis which revealed a sensitivity of 66.6%, a specificity of 91%, a positive predictive value of 46.1%, and negative predictive value of 96.1%.[4]

Kandukuri R et al[13] study revealed CT diagnosis had higher sensitivity, specificity, PPV and NPV in diagnosing various sinonasal diseases in comparison to clinical diagnosis. On correlating CT diagnosis with final diagnosis, congenital conditions have 100% sensitivity and specificity. Chronic sinusitis has 98.3% sensitivity and 97.8% specificity. For fungal sinusitis the sensitivity was 60% and specificity was 99.3%. Polyps have sensitivity of 94.4% and specificity of 98.1%. Benign neoplasms have sensitivity of 90.9% and specificity of 99.2%, malignant neoplasms have sensitivity of 94.1% and specificity of 99.3%. The p-value in all instances was <0.05, i.e. <0.0001 indicating the significance of the findings.The diagnosis of non-specific sinonasal polyps, antrochoanal polyp and mucormycosis was correctly established in most of the cases. There was a difference of opinion between the clinician and the radiologist in about 20% of non-neoplastic lesions [15]. Also CT scan of nasal polyps shows the smooth expansion of nasal fossae and pressure atrophy of the adjacent bony wall of the sinonasal cavity. Bone erosion is not common with polyps. However, in aggressive long standing polyposis, there may be significant expansion of the sinuses as well as bone erosion.[18] In the present study chief presenting complaints were of a headache (70.45%) followed by nasal discharge (43.2%), nasal obstruction (47.73%), facial pain (38.64%), allergic symptoms (15.91%), hyposmia (11.36%), epitaxis (6.82%), and mouth breathing (20.45%). Verma J et al[19] study revealed that the main presenting complaints were nasal obstruction (82%), nasal discharge (66%), Nasal mass (58%), headache & allergic symptoms (52%), external nose involvement (14%), hyposmia (14%), epistaxis (10%). Malignancy occurred in 2 out of 50 cases, 2% (one case) was of squamous cell carcinoma, and 2% (one case) was of sinonasal adenocarcinoma. In the present study the etiologic distribution of the lesions was inflammatory (50%), neoplastic benign or malignant (47.7%), and miscellaneous (2.27%). Thus, the inflammatory disease was found to be the most frequently occurring pathology affecting the PNS. Kandukuri R et al[13] study also revealed that various sinonasal pathologies diagnosed on CT are classified based on their imaging features. Most common sinonasal pathology in present study was inflammatory (77.14%) followed by benign neoplastic (12%) and malignant lesions (9.7%). Similar findings were also found in studies done by Vijay Prabhu et al.[12], Khan N et al.[14], and Vikas Dhillon et al.[15]. The most common inflammatory pathology was sinusitis followed by polyps, which was also found in study done by Azzam MA, Salami et al.[16], accounting to 33.3% and 20% resepectively. Khan N et al14 reported that Squamous cell carcinoma was the most common malignancy observed in the study and it constituted 37.5% of all the malignancy and 6.25% of all the sinonasal region. Majority of the patients were in sixth or seventh decade of life and M:F ratio was 2:1.Stallman JS et al[9] study revealed that there was a clear association between the presence of a unilateral concha, or a dominant concha (in the case of bilateral concha), and the presence of nasal septal deviation (**P** < .0001). Moreover, there was a significant relationship

between the presence of concha bullosa and deviation of the nasal septal to the contralateral side (**P** < .0001). This inverse association was present regardless of the size of the concha bullosa or degree of septal deviation. In every case, there was some preservation of air channels between the dominant concha and the nasal septum. Seventy-three percent of patients with concha bullosa had paranasal sinus inflammatory disease; 78% of patients without concha bullosa also had some form of inflammatory disease.Chandra RK et al study revealed that there is a wide range of anatomical variants that affect the many structures that compose the ostiomeatal complex and are not pathological in themselves but their presence can result in disease. Patients were stratified into three groups: no osteomeatal complex (NOMC) obstruction (n = 38; 35.8%), unilateral osteomeatal complex (UOMC) obstruction (n = 24; 22.6%), and bilateral osteomeatal complex (BOMC) obstruction (n = 44; 41.5%). The mean adjusted total disease score was 3.6, 6.3, and 12.3 for each, respectively (p < .0001). BOMC obstruction patients were significantly more likely to have asthma than those with UOMC or NOMC obstruction (52%, 17%, 16%, respectively; p < .0001). Nasal polyposis was more frequently observed in the setting of BOMC obstruction (59%) compared with either UOMC (38%) or NOMC (13%) obstruction (p < .0001). The series was also stratified by sides with osteomeatal complex (wOMC) obstruction (wOMC, n = 112) and those without osteomeatal complex (sOMC) obstruction (sOMC, n = 100). The mean ipsilateral score was calculated for the sinus cavities on each side, and this was significantly greater in the wOMC obstruction group (5.7 vs 2.0, p < .0001). The frequency of ipsilateral maxillary sinus disease was also significantly greater in the wOMC obstruction sides (p < .0001).[10] In the present study maxillary sinuses were most commonly involved in the study 77.27% cases, followed by anterior ethmoid sinus 52.27%, posterior ethmoid 43.18%, frontal sinus involvement 36.36% and sphenoid sinus involvement in 20.54% cases. Kandukuri R et al[13] study also revealed most common sinus involved was maxillary sinus followed by anterior ethmoid, posterior ethmoid, frontal and sphenoid sinuses. Present study correlates well with studies done by Suthar et al.[20], Chaitanya CS et al.[21], Kushwah APS et al.[22], where maxillary sinus was most commonly involved. In all the studies sphenoid was least involved, which is also observed in the present study. Commonest pattern of inflammation was osteomeatal unit pattern followed by sinonasal polyposis which was also observed in study by Maru YK et al.[23].

Sinus x-rays are less sensitive than sinus CT scans for demonstration of radiographic changes consistent with acute sinusitis. Sinus plain films may not be reliable enough to assist with clinical decision making. If severity of patient illness requires diagnostic certainty, more sensitive imaging studies, such as CT scans of the sinuses, should be considered[5]. CT is the investigation of choice for pre-operative evaluation of the nasal cavity and paranasal sinuses and is the gold standard for description of inflammatory sinus disease resulting from obstruction[24]. Coronal CT images closely correlates with the surgical approach[25]. Therefore, CT is the preferred study for Functional Endoscopic Sinus Surgery (FESS) because coronal images mimic the appearance of the sinonasal cavity from the perspective of the endoscope[26].

Zizmor *et al.*[27] found that mucocele most commonly occur in frontal sinus (60-65%) followed by ethmoid sinuses. Zinreich *et al.*[28] published in his study that the maxillary sinus involvement was the most frequent in inflammatory lesions, i.e., 65% followed by ethmoid cells 40%, frontal sinus in34%, and sphenoid sinus in 29% of cases. Bagul M study[29] revealed that considering the involvement of sinuses by various neoplasms in the present study, maxillary sinus was involved in 80.5% of cases, ethmoids in 66.6%, frontal in 30.5%, and sphenoid in 30.5% of cases.

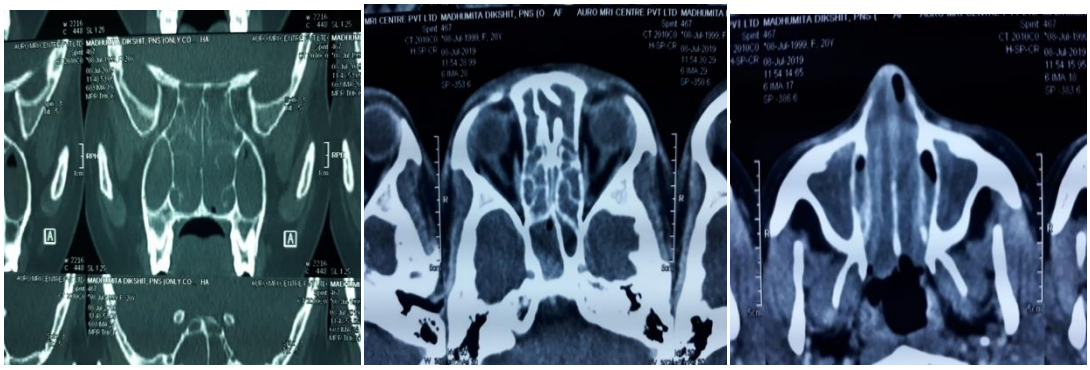

Fig1 (a, b, c): Chronic rhinosinusitis and sinonasal polyposis diagnosed in CT

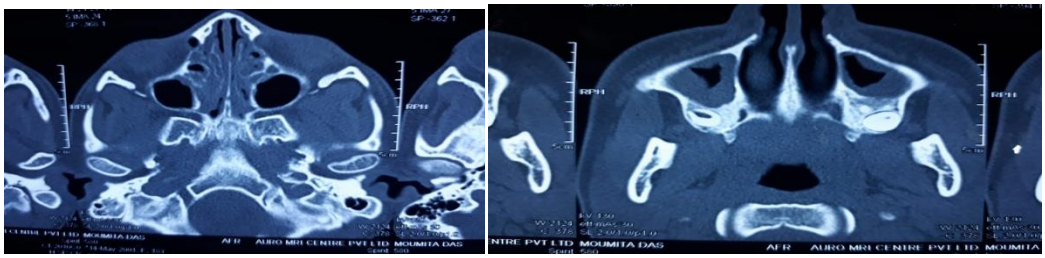

Fig (2a, 2b): Chronic rhinosinusitis and polyp in left axillary antrum on CT Scan findings

CONCLUSION

CT is the modality of choice in imaging the paranasal sinuses for evaluating the chronic diseases and associated complication. It is the modality of choice in evaluating the bone erosion or destruction. CT evaluation of PNS in symptomatic patients helps in planning the further management of the patients. Accurate delineation of disease and microanatomy locates by CT scan provides a reliable pre-operative road map. CT is the modality of choice to assess the clinically relevant anatomic variations of sinonasal region. CT is the modality of choice in imaging the paranasal sinuses for evaluating the chronic diseases and associated complications. Fungal sinusitis and dense secretions are potential pitfall on CT to differentiate them. But CT may suggest fungal sinusitis in whom it is not suspected. It is the modality of choice in evaluating the bone erosion or destruction. CT evaluation of PNS in symptomatic patients helps in planning the further management of the patient. It helps in staging the PNS disease and its extension and involvement of surrounding structures.

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