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Multidetector Computerized Tomography in Evaluation of Paranasal Sinus Pathologies

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ABSTRACT

Introduction: Multi-detector computerized tomography (CT) allows proper detection, extension, characterization of para-nasal pathologies including congenital anatomical variants. CT is also an standard guideline before definitive surgical procedure. The main aim is to find the diagnostic role of computed tomography in the evaluation of paranasal sinus pathologies.

Methods: A descriptive cross sectional study conducted among patients for diagnostic evaluation of computerized tomography of paranasal sinus. Correct diagnosis was made on basis of clinical outcome, operative findings or histopathology whichever was feasible. Diagnostic statistical tests and Pearson's Chi square test were used while correlation with final diagnosis.

Results: In our study, there were 34 males (52%) and 31(48%) females with male to female ratio of 1.09:1. The age group was ranging from 9 to 71 years with mean age of 35.7±15.6 years. The most commonly encountered sinonasal diseases were inflammatory/infective (63.1%) followed by benign neoplasm (7.7%), malignant neoplasm (3.1%) and congenital (26.1%). Sensitivity and specificity of sinusitis were 93.7% and 93.7%, fungal sinusitis were 75% and 93.1%, polyp were 91.6% and 94.4%, benign neoplasm were 80% and 97.6%, malignant neoplasm were 100% and 97.8% respectively. There was positive correlation between CT and final diagnosis as evidenced by p value of < 0.001.

Conclusion: Soft tissue, bony details, detailed assessment of paranasal sinus anatomy and pathology is facilitated in CT due to differential contrast enhancement, thus helping for proper planning, management and reduction of complications.

Keywords: Computerized tomography; Neoplasm; Paranasal sinuses; Sinusitis.

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INTRODUCTION

The nasal passage and paranasal sinuses pathologies including various conditions ranging from inflammatory, infective, neoplasm (benign and malignant) and mucocele are collectively termed as sinonasal disease. Paranasal sinus diseased condition is difficult to evaluate clinically as adjacent bony structure limits its assesement.[1, 2]

For detection of pathologies, one needs to understand the normal anatomy and physiology of paranasal sinuses. X-ray radiography shows only brief anatomical and pathological details of paranasal sinus as it allows limited study of only anterior ethmoidal sinus and upper two third of nasal cavity.[3] Though being cheap and easily accessible, X-ray are usually not recommended by clinician nowadays. In contrast computerized tomography shows patency of sinonasal passage, opacified sinuses, distribution, extent of disease including inflammatory, neoplastic conditions, any osseous destruction/ invasion in case of malignancy and congenital variation including septal deviation, concha bullosa, paradoxical curve of middle turbinate etc. In case of extension of pathology up to orbital apex, MRI is the better mode of investigation. MDCT with 3D high resolution reconstruction image is the mandatory imaging mode of investigation before definitive functional endoscopic sinus surgery (FESS) and for proper visualization of sinonasal anatomy obscured by nasal endoscopy.[4,5] Coronal CT images are usually closely related with the surgical approach.[4] MDCT when combined with FESS is very helpful in preoperative evaluation, reduction of post-operative complication and effective treatment of pathologies.[6] The main objective of our study was to find the diagnostic accuracy of multidetector computed tomography in the evaluation of paranasal sinus by assessing various CT appearances of pathologies and anatomical variants obtained through high resolution, thin slice images. The findings were correlated after proper T

here has been studies in various surgical journals regarding CT scan of paranasal sinuses revealing normal findings in symptomatic cases and abnormal findings with very little symptoms.[7,8] In 30% of asymptomatic patients, mucosal thickening of sinuses was evident and lack of specificity of sinus CT has been critically acclaimed by surgeons.[9] Thus, our study will help spreading awareness among clinician and surgeons regarding great impact of CT in paranasal sinuses as CT is indispensable tool for accurate delineation of sinus anatomy, pathology as well as congenital variants which is helpful for simultaneous treatment of both disease process and anatomical variations thus helping to reduce the recurrence and minimizing the complication during surgery.

METHODS

A descriptive cross sectional study was conducted among 65 patients

who were referred to Department of Radiology, Kathmandu Medical College for diagnostic evaluation of paranasal sinus pathologies by CT from November 2020 to April 2021. Ethical clearance was obtained from Institutional Review Committee (Reference number 2306202005) before conducting study. The following criteria were taken into consideration.
Inclusion criteria:

All patients irrespective of age and sex suffering from sinus diseases, and referred for their diagnostic evaluation, were enrolled for the study.

Exclusion criteria:

1. All postoperative cases and patients with any traumatic conditions involving PNS were excluded from the study.

2. Previously diagnosed cases of paranasal sinus pathologies.

cases undergoing treatment.

Sample size (N) was calculated by the formula Z^2 x PQ/ e^2, where pre-determined value of prevalence of the disease was 20.8 % which was referenced from a study done by researcher Chaitanya CS et al[6] based on clinical evaluation. Similarly the marginal error (e) of 10% and Z of 1.96 was put respectively.

Prevalence (P): 20.8 %,

Q =100 – Prevalence = 79.2 %

Error of the study: 10%

$$\text{Sample size (N)} = \frac{Z^2 \times PQ}{e^2}$$

$$= (1.96)^2 \times 20.8 \times 79.2 / 10^2$$

$$= 63.2 \text{ (approx 65)}$$

Sample size= 65

Detailed history including age, sex, laterality, clinical picture including nasal examination were properly recorded. Multidetector 64 slice Aquilion CT having multiplanar (MPR) and 3D reconstruction images with volumetric scan was used for detailed assessment of paranasal sinus diseases. Following parameters like patency of osteomeatal complex, mucosal thickening, fluid level, characterisation of soft tissue opacification and bony details, were taken into consideration for assessment of paranasal sinus. Slice thickness for axial and coronal planes was 3mm and inter-space was 3mm respectively. The exposure factors used were 120kvp and 60 mAs.

Statistical analysis was done by using SPSS version 20 software. For general characteristics of the study population, descriptive analyses were performed. Nominal data were presented as counts and percentages. Mean ± standard deviation were used for continuous data. Pearson's chi-square test was used to find the level of significance. Values of $P < 0.05$ were considered statistically significant. Diagnostic statistical tests such as sensitivity, specificity, PPV, NPV and accuracy of CT findings were calculated by correlating with findings of nasal endoscopy, functional endoscopic sinus surgery, histopathology, biopsy or clinical assessment after medical treatment whichever was available.

RESULTS

The age group was ranging from 9 to 71 years with mean age of patient was of 35.7±15.6 years. There were 34 males (52%) and 31(48%) females with male to female ratio of 1.09:1 as shown in figure 1

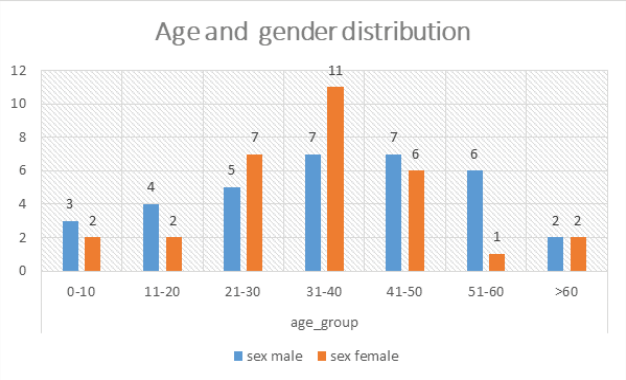

Figure 1. Age and gender distribution

Table 1.CT Distribution of cases (n=65)

Diagnosis	Number of cases (percentage)
Congenital	7(26.2%)
Inflammatory/ Infective	41(63.1%)
Benign neoplasm	5(7.7%)
Malignant neoplasm	2(3.1%)

The common anatomical variants were seven cases of deviated nasal septum(41%), three cases of concha bullosa(18%), two cases of paradoxical curve of middle turbinate(12%), pneumatised greater wing of sphenoid(12%), Haller cells (12%) each and one case of pneumatised anterior clinoid process(6%). Two cases of osteoma (40%), one case of juvenile angiofibroma(20%), inverted papilloma(20%) and fibrous dysplasia(20%) each constituted of benign neoplasm. Malignant neoplasm consisted of one case of maxillary sinus carcinoma (50%) and one case of nasopharyngeal carcinoma (50%) each.

Table 2.Etiological distribution of inflammatory pathologies in CT.

Diagnosis	Number of cases (percentage)
Sinusitis	8 (43.9%)
Fungalsinusitis	6(14.6%)
Sinonasalpolyposis	7(17.1%)
Sinusitis+Sinonasalpolyposis	9(22%)
Mucocele	1(2.4%)
Total	**41**

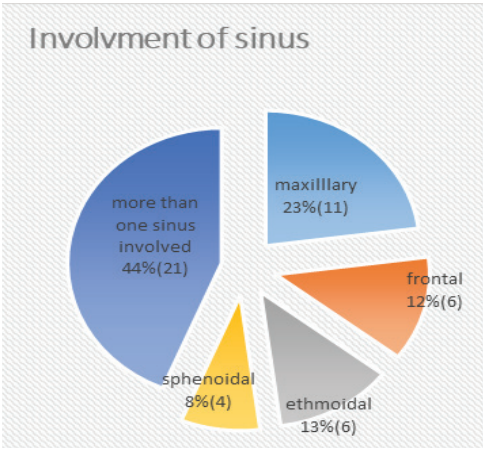

Figure 2. Commonly involved sinus in inflammatory and neoplastic cases.

Out of 48 inflammatory and neoplastic cases as shown in table number 1, 11 constituted for maxillary sinus, six for frontal sinus, six for ethmoidal sinus, four for sphenoidal and 21 for more than one sinus involved as illustrated in figure 2.

Table 3. Calculation of sensitivity, specificity, positive predictive value (PPV), negative predictive value(NPV), chi square test of CT diagnosis when correlated to final diagnosis

	Sensitivity	Specificity	PPV	NPV	Accuracy	P value
Sinusitis	93.7%	93.7%	88.2%	96.7%	93.7%	<0.001
Fungal sinusitis	75%	93.1%	50%	97.6%	91.6%	<0.001
Polyp	91.6%	94.4%	84.6%	97.1%	93.7%	<0.001
Benign neoplasm	80%	97.6%	80%	97.6%	91.6%	<0.001
Malignant neoplasm	100%	97.8%	50%	100%	97.9%	<0.001

Our study showed the correlation between CT diagnoses with final diagnosis by Pearson Chi Square test. CT findings were statistically significant as evidenced by p value of <0.001 as shown in table number three. Diagnostic test statistics such as sensitivity, specificity, NPV, PPV and accuracy of CT findings were calculated accordingly after surgery, histopathology biopsy and proper clinical assesment after medication, whichever was feasible. In cases of congenital variations, since most of patients were on follow up basis and a case of mucocele being referred to other hospital, p value and other test statistics was not calculated in these particular cases. Out of 17 congenital cases, seven constituted DNS out of which only two undergone septoplasty and rest five cases of DNS, three cases of concha bullosa, one case of pneumatised anterior clinoid process and two cases of paradoxical curve of middle turbinate, Haller cells, pneumatised greater wing of sphenoid were on follow up basis as there were no such extensive sinus pathologies due to these variations. Out of 41 inflammatory lesions in CT, 18 constituted for sinusitis, out of which 13 were on medication, who were clinically improved and five undergone FESS which revealed three cases diagnosed as chronic sinusitis showed fungal sinusitis on histopathology correlation while rest had sinusitis. Out of six cases of fungal sinusitis reported on CT, after exenteration of affected tissue and after fungal stain and culture, three were confirmed as fungal sinusitis, one case was granulomatosis with polyangitis of nasal cavity with pansinusitis and two cases were of chronic sinusitis. Seven constituted for sinonasal polyposis and nine constituted of sinonasal polyposis with sinusitis on CT. All of them had tried medications, out of which nine got improved after medications like antihistamines, antibiotic, nasal steroid, nasal saline spray, and rest seven underwent FESS, out of which two had sinonasal polyps, one had inverted papilloma and rest had only sinusitis.

Out of five cases of benign neoplasm, surgical excision was performed for juvenile angiofibroma, osteomas. A case of fibrous dysplasia of maxilla underwent resection. Surgery performed for inverted papilloma revealed sinonasal polyp on histopathology.

A case of nasopharyngeal carcinoma after taking biopsy was referred to cancer hospital for further evaluation an

d a case of maxillary sinus carcinoma diagnosed on CT after biopsy showed features of invasive fungal sinusitis.

DISCUSSION

Age ranging from 9 to 71 years was observed in our study, whereas age ranging from 6 months till 85 years was documented in Kandukuri R et al [10], Surapaneni H et al[11] and Nepal A et al.[12]In our study, the most affected age group was 31 to 40 years and the least affected were above 60 years with mean age of 35.7±15.6 years whereas in a study conducted by Kanwar SS et al[13], age group of 21–30 years (33%) were predominantly involved and between 71–80 years (0.76%) were least involved. Similarly the second and third decade was the most affected age group in one of the study.[10] There were 34 males (52%) and 31(48%) females with male to female ratio of 1.09:1 in our study. Similarly there were male predominance in a study by Kanwar SS etal[13] and Kandukuri R et al[10], with male to female ratio of 1.3:1 and 1.6:1 respectively.

Inflammatory (77.14%) followed by benign neoplastic (12%) and malignant lesions (9.7%) were commonly encountered sinonasal pathologies in one of the study.[10] In our study Inflammatory/ infective accounted for 63.1%, benign neoplasm of 7.7%, malignant neoplasm of 3.1% and congenital of 26.2% respectively. This study was compatible with other studies done by Vijay Prabhu R et al[14], Khan N et al[15], Dhillon V et al.[16]Maxillary sinus was the most commonly affected sinus followed by ethmoids, frontal, and sphenoid sinuses in cases of inflammatory pathologies as documented by Zinreich S J et al. Our study was similar to above study.[17]In a study done by Sharma BN eta al[18], deviated nasal septum followed by concha bullosa accounted for maximum of the population for congenital variantions. Similarly in our study deviated nasal septum, concha bullosa had the maximum occurrence followed by paradoxical curve of middle turbinate, Haller cells, pneumatised greater wing of sphenoid and pneumatised anterior clinoid process.

According to study by Zizmor J et al[19], frontal sinus mucocele was most commonly involved (60-65%) followed by ethmoid sinuses, whereas in our study there was only one case lof frontoethmoidal mucocele.

The specific radiological findings of fungal sinusitis was that of hyperdense polypoidal lesion associated with thinning and expansion of bony wall of the sinuses according to Mukherji SK et al[20]. The above findings were in concordance to our study.

Our study demonstrated angiofibroma as site of origin near pterygopalatine fossa and sphenopalatine foramen showing intense contrast enhancement associated with widening of pterygopalatine fossa which was similar to findings by Som PM et al.[21] The affected age group were almost exclusively in young males which was also evitable in our study.

Lund VJ et al[22] reported that inverted papilloma as enhancing mass in the middle meatus of nasal cavity extending into maxillary sinus with erosion of middle turbinate which was compatible with our study.

Our study documented that fibrous dysplasia had imaging features like ground glass appearance along with expansion of involved sinus. Commins DJ et al[23] also had same findings whereas osteoma appeared as hyperdense lesion having similar density as that of bone.

Som PM et al[21] along with our study stated that bone destruction was the major key findings in diagnosis of malignancy in addition to other features like extension of the lesion to adjacent anatomical structures with enhancement.

In our study, significant correlation between CT diagnosis and final diagnosis was observed as evidenced by p value of <0.001 along with high sensitivity, specificity values in cases of sinusitis (93.7%, 93.7%), polyp (91.6%, 94.4%), benign neoplasm (80%, 97.6%) and malignant neoplasm (100%, 97.8%) respectively. There was comparatively low sensitivity of 75% and specificity of 93.1% in cases of fungal sinusits likely due to hyperattenuating densities wrongly interpretated as fungal etiology as there are other causes like inspissated secretion and calcification in chronic sinusitis. Similar significant correlation was reported by Kandukuri R[10] as sensitivity, specificity of 98.3%, 97.8% in sinusitis, 94.4 %, 98.1% in polyp, 90.9%, 99.2 % in benign neoplasm, 94.1%, 99.3% in malignant neoplasm, 60%, 99.3% in fungal sinusitis and Kanwar SS[13] as sensitivity, specificity of 97.7%, 97.8% in sinusitis, 95 %, 98.5% in polyp, 66.6%, 91.4% in neoplasm, 66.6 %, and 91.4% in fungal sinusitis. Thus CT has immense role in evaluation of paransal sinus as it provides fine structural anatomy, proper delineation of inflammatory sinus disease resulting in obstruction, differentiation of benign and malignant neoplasm along with extrasinus extension.

Limitation:

1. Future researchers can include more number of patients for longer duration for more accuracy.

2. There was subjective limitation on final diagnosis based on clinical assessment after medical treatment.

CONCLUSION

This current study proved that there is a better sensitivity, specificity and accuracy of CT in assessment of paranasal sinus pathologies as evident by significant correlation of CT with final diagnosis with p value < 0.001. CT plays an important role in studying fine bony details, localization, extension of pathologies, associated complication and complex sinonasal anatomy not visualized by physical examination or nasal endoscopy. CT is preferable before definitive surgery which gives proper guidance to the otolarynogologist as coronal CT image is closely related to surgical approach and thus ultimately leading to effective treatment, management and prevention of complications.

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