International Journal of Research in Medical Sciences
Rashmi K et al. Int J Res Med Sci. 2017 Feb;5(2):537-542
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20170147

Original Research Article

Computed tomographic evaluation of inflammatory sinonasal diseases

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Received: 28 November 2016
Accepted: 23 December 2016

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ABSTRACT

Background: Computed Tomography plays a major diagnostic role in patients with inflammatory sinonasal diseases and determines the mode of management by displaying the complex osteomeatal anatomy, determining anatomical variations, extent of disease and characterizing various inflammatory sinonasal diseases. Purpose of the study was to assess the role of CT in evaluation of inflammatory sinonasal diseases by evaluating the sensitivity and specificity of CT in diagnosis of various inflammatory Sinonasal diseases.
Methods: In this hospital based prospective study 122 patients with symptomatic inflammatory sinonasal diseases were evaluated by 16 slice MDCT. CT diagnosis is correlated with final diagnosis obtained from findings of nasal endoscopy/Functional Endoscopic Sinus Surgery, histopathological examination and fungal culture. Statistical analysis was done by descriptive and inferential statistics using Test statistics (sensitivity, specificity, PPV, NPV and accuracy) and Z test for single proportions (Z value >1.96 is considered significant). Software used in the analysis was SPSS 17.0 version and graph pad prism 6.0 version and $p < 0.05$ is considered as level of significance.
Results: On correlating CT diagnosis with final diagnosis, Chronic Sinusitis had 98.41% sensitivity and 96.61% specificity, fungal sinusitis had 66.67% sensitivity and specificity 99.14%, polyps had sensitivity of 94.59% and specificity of 97.6%, the rest of the inflammatory conditions had sensitivity 93.7 % and 99% specificity. P value in all instances was <0.05, i.e. <0.0001, indicating the significance of the findings.
Conclusions: CT is the diagnostic modality of choice in evaluation of various inflammatory pathologies and associated complications thereby planning the further management of the patient.

Keywords: CT, FESS, Inflammatory sinonasal pathologies

INTRODUCTION

Inflammatory sinus disease is a large worldwide public health problem. In the recent years, there has been an immense usage of functional endoscopic sinus surgery for the treatment of inflammatory sinus disease.

This substantial increase in the use of FESS leads to a consequent increase in the volume of CT examination obtained both as a diagnostic tool and for assessment of osteomeatal complex prior to surgery.[1-2] Coronal CT has become the investigation of choice as it imitates the endoscopist's view of the sinonasal cavity. The display of detailed osteo meatal complex anatomy by CT scan provides intra operative road maps for sinus surgeon. Therefore, CT has now become compulsory for imaging of nasal cavity and paranasal sinuses prior to FESS.[3-4]

Multidetector Computed Tomography enables the assessment of the sinonasal passages patency and shows the effect of anatomic variants, inflammatory disease or both on patency. MDCT permits the reconstruction of sagittal and coronal images from a single imaging data set. Axial and sagittal reconstructions are especially useful in delineating various anatomic abnormalities, which can lead to surgical complications.[5] Diagnostic endoscopy and CT together has become the mainstay in the evaluation of sinonasal diseases.

Hence CT has enormous value and offers standard imaging of sinonasal diseases.[6] CT is superior to X-ray and MRI and is the imaging modality of choice for diagnosing chronic rhinosinusitis.[7] Present study highlights the significant role of CT in diagnosis and characterisation of various inflammatory sinonasal diseases.

Aim of the study was to assess the role of CT in the evaluation of inflammatory sinonasal diseases and objectives of the study were to characterize various inflammatory sinonasal diseases with help of CT parameters, to correlate findings of CT with final diagnosis obtained from diagnostic nasal endoscopy/ Functional endoscopic sinus surgery, fungal culture and histopathological findings and evaluate sensitivity and specificity of CT in the diagnosis of inflammatory Sinonasal diseases.

METHODS

This hospital-based prospective correlational study was carried out in Department of Radio diagnosis of AVBRH hospital between August 2014 to September 2016. Institutional ethical approval was obtained for the study.

The sample size was calculated by the formula $n_{Se} = Z^2_{\alpha/2}$ Sen (1-Sen) ÷ d^2 × Prev

For α= 0.05, $Z_{\alpha/2}$ is inserted by 1.96; Sen and Prev are the pre-determined values of sensitivity and prevalence of the disease respectively and d is the maximum marginal error which is pre-determined by the clinical judgment of investigators.[8]

The pre-determined value of Sensitivity was 85% (the overall sensitivity of CT in the diagnosis of inflammatory diseases obtained in previous study) and prevalence is 40 (prevalence of sinonasal diseases in AVBRH hospital, Wardha).[6] Marginal error d = 0.10

1.96x 1.96 x 0.85 x0.15/ 0.10x 0.10 x 0.40 = 122

The main sources of data were 122 symptomatic patients referred from Department of Otorhinolaryngology, Acharya Vinobha Bhave Rural hospital, Sawangi Meghe, Wardha, with clinically suspected sinonasal pathologies. Patients with Sino facial trauma, pregnant women, patients allergic to contrast agents and those needing sedation are excluded from the study.

Investigation carried out in the study

CT scan was carried out in a Philips 16 Slice BRILLIANCE 190P MDCT machine in all patients and images were acquired in the axial plane and coronal reformations were done. Post contrast study was done in those who required further evaluation. Patient position was supine. Raw slice thickness was 3mm thickness and Increment 1.5mm. Reconstructed slice thickness was 1mm and Increment 0.5mm. Extent for axial sections was from hard palate to upper margin of the frontal sinus and Coronal reformations were performed perpendicular to the plane of hard palate through the maxillary sinuses. Exposure factors used were 120 kvp and 150mAs. Scan time was 10sec. Soft tissue window level and width (60/370) and bone window level and width (500/1500). Omnipaque 350 was used if indicated, at a dose of 1ml/kg weight as a single intravenous bolus injection after estimation of serum creatinine level.

Informed consent from the patients needing intravenous contrast administration was received CT findings were evaluated in all the patients and characterization of the various inflammatory sinonasal lesions were done with help of various CT parameters. Lund Mackay scoring was done in suspected cases of chronic rhinosinusitis. Final diagnosis is obtained from findings of diagnostic nasal endoscopy/FESS, histopathological examination and fungal culture. CT diagnosis was then correlated with the final diagnosis.

Statistical analysis

Statistical analysis was done by using descriptive and inferential statistics using Test statistics (sensitivity, specificity, PPV, NPV and accuracy), chi square test and Z test for single proportions (Z value >1.96 is significant). Software used in the analysis was SPSS 17.0 version and graph pad prism 6.0 version and p <0.05 is considered as level of significance.

RESULTS

Present study included 77 males (63.2%) and 45 females (36.8%) aged between 5 and 80 years. The most common symptom with which the patients presented were the nasal obstruction and nasal discharge.

Table 1: Sinus diseased.

Sinus	Number (n= 122)	Percentage (%)	z-value
Maxillary	91	74.6%	18.9 S
Anterior ethmoidal	86	70.49%	17.09 S
Posterior ethmoidal	74	60.65%	13.7 S
Frontal	55	45.08%	10.01 S
Sphenoidal	41	33.6%	7.86S

Table 2: CT Findings -deviated nasal septum.

DNS	Number (n=122)	Percentage (%)	z-value
No DNS	65	53.3%	11.8S
Towards left	21	17.2%	5.04 S
Towards right	36	29.5%	7.19 S
Total	57	46.7%	10.37 S

The maxillary sinus was most commonly affected sinus as shown in (Table 1).

Most common anatomical variation was Deviated nasal septum which was mostly towards right side as shown in (Table 2). The second common anatomical variation was concha bullosa (Figure 1) as shown in (Table 3).

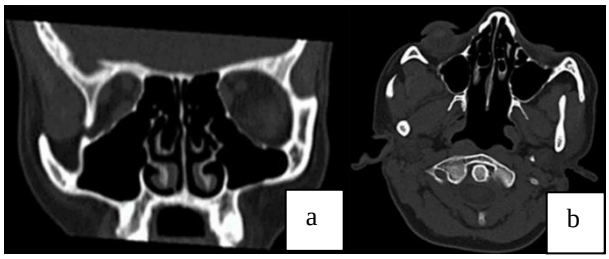

Figure 1: Coronal (a) and axial (b) bone window images shows bilateral concha bullosa.

Table 3: CT Findings - concha bulosa.

Concha bullosa	Number (n=122)	Percentage (%)	z-value
No	81	66.4%	15.5 S
Left	15	12.2%	4.12 S
Right	20	16.4%	4.89 S
Bilateral	6	5%	2.53 S
Total	41	33.6%	7.86 S

Table 4: CT Findings - osteomeatal unit obstruction.

OMU obstruction	Number	Percentage (%)	Z-value
No	55	45%	10 S
Left	17	14%	4.45S
Right	12	9.8%	3.64S
Bilateral	38	31.2%	7.4 S
Total	67	55%	14.8 S

Table 5: Distribution of cases with inflammatory etiology.

Inflammatory/ infective	Number of cases (n=122)	Percentage (%)	z-value
Chronic Sinusitis (other than fungal)	64	52.5%	11.6 S
Sinonasal polyps	37	30.4%	7.3 S
Sinusitis + polyps	13	10.6%	4.67 S
Fungal	5	4 %	2.35 S
Rhinoscleroma	2	1.64%	1.43 NS
Mucocele	1	0.82%	1.01 NS
Total	122	100%	

The osteomeatal unit was involved in 55% of patients as shown in (Table 6). The various inflammatory sinonasal diseases diagnosed on CT were chronic sinusitis (Figure 2), fungal sinusitis, sinonasal polyps (Figure 3), mucoceles, rhinoscleroma (Figure 4). The distribution of inflammatory cases is shown in (Table 5).

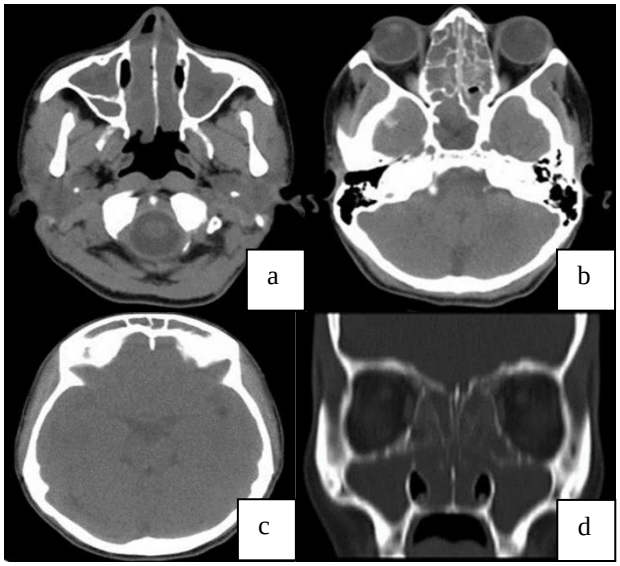

Figure 2: Axial (a, b, c) and coronal (d) CT images showing gross mucosal thickening in bilateral frontal, maxillary, ethmoid and sphenoid sinuses and nasal cavity. Bilateral pan sinusitis with bilateral osteomeatal unit obstruction and spheno ethmoidal recess pattern of inflammation. Bony septum is seen in right maxillary sinus.

Table 6: Lundmackay score.

Lundmackay Score	Number (n= 82)	Percentage (%)
<5	14	17.1%
6-10	15	18.3%
11-15	17	20.7%
16-20	24	29.2%
21-24	12	14.6%
Total	82	100%

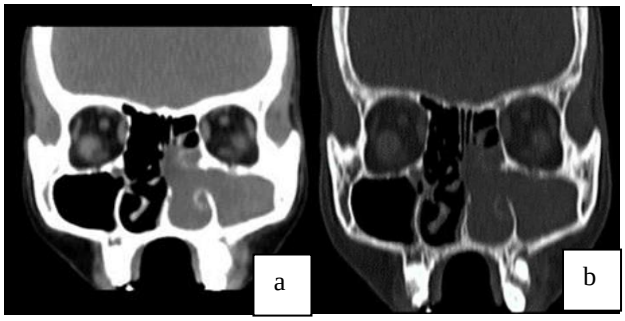

Figure 3: Coronal soft tissue (a) and bone window (b) CT images show left antrochoanal polyp. It is histologically proven.

Lund Mackay scoring for chronic sinusitis was done in 82 patients as shown in (Table 6). CT findings were same

as Diagnostic nasal endoscopy/ Fess findings in 115 (94.26 %) patients and different in 7 (5.74%) patients. Correlation of CT findings with final diagnosis is shown in (Table 7).

Table 7: Correlation of CT with final diagnosis -an evaluation.

Parameters	Sensitivity	Specificity	PPV	NPV	Accuracy	P value	Result
Chronic Sinusitis	98.41%	96.61 %	96.88%	98.28%	97.54%	0.0001	Significant
Fungal sinusitis	66.67%	99.14%	80.00%	98.29%	97.541%	0.0001	Significant
Polyps	94.59%	97.65%	94.59%	97.65%	96.72%	0.0001	Significant
Other inflammatory conditions	93.75%	99.06%	93.75%	99.06%	98.36%	0.0001	Significant

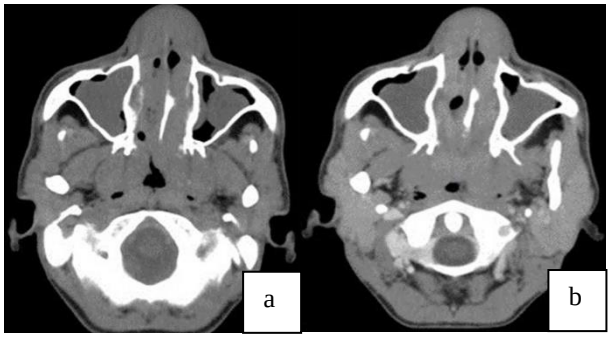

Figure 4: Axial pre (a) and post contrast (b) CT images show ill-defined soft tissue attenuating mass in the nasal cavity with moderate post contrast enhancement causing widening of the nasal cavity and destruction of hard palate. There is nasopharyngeal extension of mass. There is deviated nasal septum to the left. There is mucosal thickening with opacification of bilateral maxillary sinuses. It is histologically proven case of rhinoscleroma.

DISCUSSION

Recently CT has become the diagnostic modality of choice for imaging of nasal cavity, paranasal sinuses and for depicting various inflammatory sinonasal diseases. Acute sinus infection is mostly evaluated by clinical assessment, whereas persistent and chronic sinus disease refractory to medical therapy is investigated by CT. CT is used as an integral part of surgical planning for removal of disease in the osteomeatal complex region and also for creating intra operative road maps. Therefore, the use of CT with FESS helps the sinus surgeon to treat the patients more effectively and reduces complications.

In the present study the patient's age ranged between 5-80 years. The range was consistent with study done by Bist S, et al.[9] Maximum numbers of patient's (61%) were aged between 21-30 years. Similar results were reported in another study by Iseh KR et al and Vijay Prabhu R et al accounting to 65.3% and 60% respectively.[10,11] The present study showed the preponderance of males (63.2%) over females (36.8%). Preponderance of males over females was also observed in studies done by Iseh KR et al, Dua K et al, Kushwah APS et al, Lathi A et al, Azzam M.A. Salami et al and Ali MI et al.[10,12-16]

Male: female ratio in the present study is 1.7:1 which is consistent with study done by Bist S, et al.[9] The most common symptoms in our study are the nasal obstruction and nasal discharge which was also seen in studies done by Bist S, et al, Ali MI et al, Rao K et al.[9,16,17]

The most common anatomical variation observed in present study was DNS which was seen in 46.7%. Similar finding was also noted in studies done by Bolger et al (40%), Babble RW et al (40%), Earwaker et al (44%), Dua K et al (44%), Thimmappa TD et al (47%), Vijay Prabhu et al (48%) where DNS was the most common anatomical variation.[11,12,18-21] Concha bullosa was the second common anatomical variation which was seen in 33.6% patients which can be comparable with studies done by Vijay prabhu et al (28%) Asruddin et al (28%), Shroff et al (33%), Zinreich SJ et al (34%), Thimmappa TD et al (37%). In literature, the occurrence of concha bullosa varied between 16 -53%.[11,12,21-24] OMU was involved in 55% patients which were also seen in study done by Kushwah APS et al (54%).[13]

Most common sinus involved in our study was maxillary sinus in (74.6%) patients. Similar finding was also seen in studies done by Chaitanya CS et al, Arun Kumar et al and Suthar BP et al.[6,28,29] Studies in literature showed involvement of maxillary sinus and anterior ethmoid sinus more common.[6,12,13,15,18,25,28-34] In all the studies sphenoid was least involved, which is also observed in present study. In the present study, Chronic sinusitis (52.5%) was most common inflammatory pathology followed by sinonasal polyps (30.4%) which were also found in studies done by Azzam M.A. Salami et al accounting to 33.3% and 20% resepectively. Chronic sinusitis was also most common in study done by Vijay prabhu et al accounting to 56%.[11,15]

In present study CT has shown least sensitivity in diagnosing fungal sinusitis which was 66.67% and specificity was 99.41%. This can be compared to study

done by Lanza D C, Dhong H J et al where the sensitivity of CT to diagnose fungal sinusitis was 62% and specificity was 99%.[35] In the study done by Chaitanya CS et al CT again has lower sensitivity of 62.5% and specificity of 97.9% in diagnosing fungal sinusitis.[6] In a retrospective study done by Zenreich SJ et al the sensitivity was 76%.[36]

Endoscopic/ FESS findings were similar to CT in 115 (94.26%) and different in 7 (5.74%) patients which can be compared to study done by Chaitanya CS et al where Endoscopic / FESS findings were similar to CT findings in 99 (95.2%) patients and different from CT findings in 5 (4.8%) patients.[6] All the false positive or false negatives were related to fungal sinusitis and early nasal polyps. In a study done by Gupta Y et al CT missed 5 cases of polyp which was diagnosed on nasal endoscopy and endoscopy did not show one case of polyp which was reported in CT.[37]

On correlating CT diagnosis with final diagnosis, Chronic Sinusitis had 98.41% sensitivity and 96.61% specificity. Polyps had the sensitivity of 94.59% and specificity of 97.65% other inflammatory conditions like mucocele, rhinoscleroma, etc., had the sensitivity of 93.75% and specificity of 99.06%. P value in all instances was <0.05 i.e. <0.0001, indicating the significance of the findings. The findings can be compared with the study done by Chaitanya CS et al[6] where chronic sinusitis had 98.2% sensitivity and 96% specificity. Polyps had the sensitivity of 96.9% and specificity of 98.6%.

Limitations

The main pitfalls of CT in the present study were noted in the diagnosis of early nasal polyps and fungal sinusitis. Other disadvantages of CT include motion artifact and limited soft tissue resolution. The complication of sinonasal pathologies intra cranial or intra orbital extension of the disease process is better assessed by MRI.

Recommendations

CT is the best modality for imaging of the inflammatory sinonasal diseases, both for diagnosis and characterizing the lesions. Thereby it plays a major role in the better planning of management. CT helps in evaluation of sinonasal anatomy, diagnosing various anatomical variations and extent of the disease process which is required for deciding the surgical approach for functional endoscopic sinus surgery. Therefore, CT provides a road map to fess surgeon.

CONCLUSION

This was a prospective correlational study carried out on 122 symptomatic sinus diseased patients. On evaluating patients who had undergone CT PNS, DNS was the most common anatomical variation followed by concha bullosa. The most common sinus involved was maxillary sinus and sphenoid sinus was the least involved. The most common inflammatory pathology diagnosed on CT was chronic sinusitis followed by polyps. In our study, CT had significant sensitivity and specificity in diagnosing chronic sinusitis, sinonasal polyps and other inflammatory pathologies. The least sensitivity was noted in the diagnosis of fungal sinusitis. The other drawback of CT noted in present study was missing the diagnosis of early nasal polyps.

The real value of CT lies in evaluating the complex sinonasal anatomy, anatomical variations and defining the exact location, extent of lesion and involvement of adjacent structures. Thus, CT plays an important role in diagnosing and also in adding important findings for the better management of the patients with inflammatory sinonasal diseases. To conclude, this study proves the significance of CT in diagnosing sinonasal pathologies and their management.

ACKNOWLEDGEMENTS

Authors would like to thank Dr. Suresh Phatak Professor and Head of the Department, Department of Radio diagnosis, AVBRH, who with his constant motivation; valuable guidance brought this study to the present form. Authors would also like to thank all the technical staff, Department of Radio diagnosis and other members of AVBRH Hospital for their co-operation and Mr. Babar, statistician, Community medicine Department for helping with the statistical analysis of the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Rashmi K, Phatak S. Computed tomographic evaluation of inflammatory sinonasal diseases. Int J Res Med Sci 2017;5:537-42.