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Radiologic Variations of Nose and Paranasal Sinuses: A Ct Based Study

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ABSTRACT

Background: *Chronic rhinosinusitis (CRS) refers to a group of disorders characterized by inflammation of the mucosa of the paranasal sinuses. Computed tomography (CT) scans used as the gold standard diagnostic modality of nose and paranasal sinus diseases. There has been a lot of studies regarding the anatomic variations leading to pathogenesis of paranasal sinus diseases. Considerable progress has been made in the medical and surgical control of these conditions; however, a large number of questions relating to the diagnosis, evaluation, and treatment of the diseases remain unanswered.*

Material and Methods: *The study included 82 clinically diagnosed cases of chronic rhinosinusitis who underwent CT scan were taken into the study. Supportive data was obtained from nasal endoscopy. The anatomical variations and pathological findings of the nose and paranasal sinuses were seen in the CT scan.*

Results: *The mean age (± SEM) of presentation was 34.11 (± 1.42) years while most patients were from the age group of 18 to 30 years. Males were predominating the study group with 62.2% while 37.8% were females. Most common anatomic variation was DNS with 92.68% CT reported patients. This was followed by Inferior turbinate hypertrophy, septal spur, concha bullosa and agger nasi cells.*

Conclusion: *CT scan is considered gold standard for sinonasal imaging. Diagnostic endoscopy and CT scan is a must prior to any functional endoscopic sinus surgery. They help in assessing the extent of sinus disease and to know the variations and vital relations of the paranasal sinuses. CT scan assists the surgeon as a "road map" during ESS.*

Keywords- *Chronic rhinosinusitis; Nasal endoscopy; CT scan; Anatomic variation*

INTRODUCTION

Chronic rhinosinusitis (CRS) is one of the common diseases affecting people globally with significant negative impact on quality of life. The term sinusitis refers to a group of disorders characterized by inflammation of the mucosa of the paranasal sinuses. Because the inflammation nearly always also involves the nose, it is now generally accepted that 'rhinosinusitis' is the preferred term to describe the inflammation of the nose and paranasal sinuses.

CT scan had been well accepted as a mandatory pre-requisite for endoscopic sinus surgery, in suspected complications of sinusitis and in neoplasms of the nose and paranasal sinuses. In the diagnosis of CRS, its association with the symptoms score have been evaluated by a number of studies. However, due to the lack of agreement, high cost of CT scan and exposure to ionizing radiation, many do not recommended CT scan to form part of routine work up for CRS. Endoscopy often forms the first line

investigation in chronic rhinosinusitis, but confirmation of the diagnosis is always by the CT scanning.

MATERIALS AND METHODS

The present study was conducted in Department of Otorhinolaryngology, Sir Sunderlal Hospital, Banaras Hindu University, Varanasi from ,January 2014 to July 2015. Sample size of 82 patients were included in the study with informed consent and clearance of ethical committee.

The patients were clinically diagnosed as a probable case of chronic rhinosinusitis on the basis of history and nasal endoscopy and then subjected to the investigative procedure viz. CT scan.

Thin slice coronal, axial and sagittal films were obtained both in soft tissue window and bone window for optimum visualization of all the structures. The investigations were done prior to initiation of any therapy. The selection of cases was based on a detailed clinical history of rhinosinusitis with duration of symptoms more than 12 weeks.

Criteria for Selection of Cases:

Inclusion criteria:

- Patient attending outpatient department (OPD) or admitted patients who were clinically diagnosed as Chronic rhinosinusitis.
- Only those cases were registered, who gave full informed consent for the study.
- Adults of all age groups and both sexes were included.

Exclusion criteria:

- Patients with rhinosinusitis less than 12 weeks duration.
- Patients with allergic rhinitis.
- Patients with history of previous sinonasal surgeries.
- Patients with extensive nasal polyposis.
- Patients less than 18 years age.

Clinical diagnosis was based on subjective symptoms as defined by American Academy of Otolaryngology-Head and neck surgery (AAO-HNS) task force criteria, which was revised in 2002 by the Sinus Allergy Health partnership (SAHP) task force. [(1)(2)(3)]

TABLE 1: Criteria for diagnosing chronic rhinosinusitis

Major symptoms	**Minor symptoms**
Nasal obstruction/blockage	Fever
Nasal discharge/purulence/discolored postnasal discharge	Halitosis
Hyposmia/anosmia	Headache
Facial congestion/fullness	Cough
Facial pain/pressure (facial pain must be accompanied by another major factor to qualify for CRS).	Fatigue
	Dental pain
	Ear pain/ear pressure or fullness.
The guidelines define that the patient must have at least two major factors or one major factor with two or more minor factors, or nasal purulence on examination. Facial pain is not considered to be a symptom of CRS without other nasal signs and symptoms. The signs and symptoms should persist for at least 12 weeks to qualify as a case of chronic rhinosinusitis.	

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Clinical diagnostic criteria of CRS Revision (2002 SAHP Task Force)[3] :

1- Duration of disease is qualified by ongoing symptoms more than 12 weeks or more than 12 weeks of physical findings (signs will support the symptom time duration)

2- One of these signs of inflammation in association with symptoms:

a) Discoloured drainage, nasal polyp or polypoid swelling on physical examination with anterior rhinoscopy or nasal endoscopy

b) Edema or erythema of middle meatus as identified by nasal endoscopy

c) Generalized edema, erythema or granulation tissue (if it does not involve middle meatus or ethmoid bulla, radiological imaging is required.

d) Imaging modalities for confirming the diagnosis: CT scan demonstrating mucosal thickening, bone changes or air fluid level. Plain
X-ray with mucosal thickening of more than 5 mm or complete opacity.
(Plain X-ray without equivocal signs listed in A, B or C is not considered for diagnosis. MRI scan is not recommended for routine diagnosis because of lack of specificity. The endoscopy of frontal recess, middle meatus and sphenoethmoid recess were reviewed for presence of polyps, mucosal edema, congestion, discharge, scarring or crusting.)
All the assessments of endoscopy and CT were performed independently and assessors were blinded to each others' scores. The anatomical findings were assessed for every patient.
The data was tabulated and analyzed using the software program 'Statistical Product and Service Solutions' (SPSS) version 16.

OBSERVATIONS AND RESULTS

Only adults were included in the study. The mean age (+ SEM) of presentation was 34.11 (+ 1.42) years while most patients were from the age group of 18 to 30 years. Males were predominating the study group with 62.2% while 37.8% were females.
The table 2 depicts the anatomical findings seen in CT scan. 92.68% patients had deviated nasal septum, 57.31% had inferior turbinate hypertrophy, 40.24% had septal spur, 30.48% had concha bullosa, agger nasi cell is found in 26.82%.
Lesser number of patients had paradoxical middle turbinate (14.63%), onodi cells were found in 10.97%, haller cells in 9.7% and bent uncinate process only in 1.21%.

Table 2 : CT scan findings (Anatomical variations)

CT scan findings	No. of patient	Percentage
DNS	76	92.68%
Septal Spur	33	40.24%
Inferior Turbinate Hypertrophy	47	57.31%
Concha Bullosa	25	30.48%
Onodi Cells	9	10.97%
Haller Cells	8	9.7%
Agger Nasi Cells	22	26.82%
Bent Uncinate Process	1	1.21%
Paradoxical Middle Turbinate	12	14.63%

The following table 3 shows the frequency of pathological findings in CT scan. Sinus haziness and ostiomeatal complex involvement are the most important factors which are to be studied in CT scan of paranal sinuses.

Table 3 CT scan findings (Pathological findings)

CT Scan Findings	**No. of patient**	**Percentage**
Polyp in Middle Meatus	9	10.97%
Maxillary Sinus opacification	58	70.73%
Ethmoidal Sinus opacification	48	58.53%
Sphenoidal Sinus opacification	30	36.58%
Frontal Sinus opacification	22	26.82%
Blocked Hiatus Semilunaris	28	34.14%
Frontal Recess Block	10	12.19%
Sphenoethmoid Recess Block	17	20.73%

Frequency of involvement of sinuses is shown in table 4. Most patients had multiple sinus involvement (48.78%). Pansinusitis was found in 12.19%. Isolated sinus involvement is not much common. Maxillary sinus was involved alone in 21.9%, isolated etmoidal in 1.21%, isolated sphenoidal in 6.09% and isolated frontal in 2.43%. 7.3% patients had no sinus involvement.

Table 4 : Involvement of Sinuses in CT

CT scan findings	No. of patient	Percentage
Maxillary Sinus	58	70.73%
Ethmoidal Sinus	48	58.53%
Sphenoidal Sinus	30	36.58%
Frontal Sinus	22	26.82%
Isolated Maxillary	18	21.9%
Isolated Ethmoidal	1	1.21%
Isolated Sphenoidal	5	6.09%
Isolated Frontal	2	2.43%
Pansinusitis	10	12.1%
Involvement of Multiple Sinuses	40	48.78%
None of The Sinuses Involved	6	7.3%

All the cases in our study were clinically diagnosed as a case of chronic rhinosinusitis. However after CT scan and endoscopy the final diagnosis showed. 92.68% were actually cases of chronic rhinosinusitis. 3 cases were of deviated nasal septum, 1 case each of atrophic rhinitis, carcinoma maxilla and rhinitis.

DISCUSSION

Chronic rhinosinusitis remains one of the most common diseases with negative impact on quality of life. It has a high prevalence rate of about 10.9% as found out in an European study the GA2LEN study.[4] CT scan is considered as the gold standard in diagnosing rhinosinusitis while nasal endoscopy is performed to look for anatomic variations and mucosal changes. It has been recommended that either a CT scan or endoscopic evaluation of nose (preferably with photo or video documentation) should be a part of any prospective clinical trial, as it provides the majority of objective data used to diagnose CRS.[5-9]

The pneumatization of the middle turbinate (concha bullosa) may block the entrance to the middle meatus by creating area of mucosal contact.[12] It has been implicated as possible etiology factor in recurrent sinusitis due to its postulated negative influence on paranasal sinus ventilation.[13] Presence of concha bullosa is also a variable finding reported by Kennedy et al (1988) in 36%, Lloyd (1990) in 14% and Lloyd et al in (1991) in 24% patients, Zinreich et al (1989) in 36%, Asruddin et al(2001) in 28%.

In our study the prevalence of DNS was found to be staggeringly high at 92.68% which was way above the findings of other studies. A study done in Indian population found out DNS in 65% of patients with headache or nasal symptoms.[22] Another study found out prevalence of DNS to be 80% which was closer to our result than others.[10]

As demonstrated in the table 5, In our study concha bullosa was seen on CT examination in 25 (30.48%) cases. Which is comparable to studies of Zinreich et al , Shroff et al (1996) and Wani et al (2006).

Controversially, in another study it was said that DNS and Concha bullosa are said not to have any significant correlation in pathogenesis of CRS.[11] But we found high prevalence of DNS amongst our patients (92.68% reported in CT scan).

Paradoxical middle turbinate may block the entrance to the middle meatus.[12] It is a very variable feature, Lloyd (1990) reported it in 17% of cases, 12% by Asruddin et al (2001), 15% by Zinreich et and Shroff et al 16% and Bolger et al 6.1%. In our study as demonstrated in table, on CT scan paradoxical bent middle turbinate was found in 14.63% cases which is comparable to Zinreich et al 1987, Lloyd et al (1990) , Shroff et al 1996 and Asruddin et al 2001.

Haller cells protrude from the floor of orbit. These are known to cause narrowing of the maxillary ostium. We found the presence of Haller cells in 9.7%. Lloyd reported frequency of Haller cells as 2% and 15% cases in two separate studies done in 1990 and 1991.[14,15] Thus there is a wide variation in Haller cell frequency. Our findings were closer to Zinreich et al findings who found haller cells cells in 10% of cases

Agger nasi cells on the lateral wall represent the most anterior of the anterior extra ethmoid air cells.[21] Agger nasi cells are sid to obstruct the frontal recess thereby obstructing frontal.

sinus drainage. In our study, agger nasi were present in 26.82% patients. The presence of agger nasi cells is a variable finding. As Lloyd (1990) reported its presence in 3% cases while Maru et al found in 88.5% casesThe uncinate process may be bent in two difference directions. Its posterior margin may be deflected medially so that is approximates to the middle turbinate; or it may be laterally narrowing the hiatus semilunaris and the ethmoid infundibulum (Lloyd 1990).[14] In our study on the CT plate examination, the bent uncinate process was present in 1 case of 82 cases. It is a variable finding. (Lloyd 1990) reported its presence in 16% cases and the same author reported in another study done in 1991 its presence in 21% cases. Our result is comparable to the study of Asruddin et al (2001) who obtained 2%.

There are significant number of various parameters that cannot be visualized at nasal endoscopy viz middle meatus, bulla ethmoidalis, hiatus semilunaris and frontal recess. This is because in some cases it is impossible to pass the endoscope beyond certain point due to severe anatomical abnormalities like a severely deviated nasal septum, paradoxical middle turbinate, or a concha bullosa. CT scan definitely prove to be very helpful in these cases.

For proper evaluation of ethmoid sinuses, CT is mandatory because inflammatory changes in the middle meatus and ethmoids are poorly seen on plain radiographs. In this setting CT can establish the extent of disease, help the clinician determine if full patency of the narrow passage has been reestablished after surgery. For functional endoscopic sinus surgery, CT is a prerequisite to know the "road map" for surgery (Zinreich et al 1987).[13]

TABLE 5: COMPARISON OF ANATOMIC VARIATIONS WITH PREVIOUS STUDIES

Anatomic variants	Zinreich et al [13]	Lloyd et al[14]	Lloyd et al [15]	Bolger et al [17]	Shroff et al [18]	Asruddin et al [16]	Maru et al [19]	Wani et al[20]	Present study
Concha bullosa	36%	14%	24%	51%	33%	28%	42.6%	30%	**30.48%**
DNS	21%	-	-	40%	33%	38%	55.7%	25.3%	**92.68%**
Paradoxical middle turbinate	15%	17%	15%	6.1%	16%	12%	9.8%	9.33%	**14.63%**
Haller cell	10%	2%	15%	5.1%	6%	28%	36.1%	8.66%	**9.7%**
Enlarge ethmoid bulla	8%	17%	18%	-	8%	9%	-	-	-
Bent Uncinate process	3%	16%	21%	2.5%	3%	2%	9.8%	11%	**1.21%**
Agger nasi cell	-	3%	14%	-	9.8%	48%	88.5%	9.33%	**26.82%**
Maxillary antrum septae	-	-	-	-	-	18%	6.6%	-	-

CONCLUSION

Advantages of CT scan:

- It shows progressive deeper structures as the surgeon encounters them during operation (eg: uncinate process, bulla ethmoidalis, ground lamella, sphenoid sinus, in an A-P direction).
- It shows the relationships of the above structures to important areas such as the lamina papyracea and skull bone, reducing the morbidity.
- Dehiscence of the lamina papyracea are better visualized.
- Comparative study of two sides of the ethmoids labyrinth is possible.

To sum up, the CT scan serves as a “road map” for the surgeon as he negotiates the potentially hazardous clefts of the PNS unit. It is a non invasive, rapid, convenient investigation, which helps in documentation and education. As already mentioned CT scan delineates the extent of disease, anatomical and pathological variations far better than other methods.

Disadvantages of CT scan:

- Radiation dose to the sensitive areas like cornea and lens is particularly high when axial cuts are taken nearly 185 times more than that recorded for plain X-rays. Careful positioning of the patient in the scanner can reduce this.
- Inability to differentiate between fibrous tissue (post-op) and inflammatory mucosal disease. Thus CT scan falsely indicates recurrent disease because of the presence of post operative fibrosis in the paranasal sinuses (i.e. specificity of CT is lower than the sensitivity of CT)
- Relatively expensive investigation.

CT scan should be used to provide supplementary clinical data to the history and endoscopic examination, and assist in directing surgical treatment to the affected areas.

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