

Anatomic Variations of the Nose in Chronic Rhinosinusitis: Correlation between Nasal Endoscopic and Computerized Tomography Scan Findings and a Review of Literature

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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. Nasal endoscopy and computed tomography (CT) scans are successfully used as diagnostic modalities of nose and paranasal sinus diseases. There have been many 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.

Materials and methods: The study included 82 clinically diagnosed cases of CRS who underwent CT scan and were advised to undergo diagnostic endoscopy. The anatomical findings of the nose were compared to see correlation between nasal endoscopy and CT scan.

Results: The mean age (\pm standard error of the mean) of presentation was 34.11 (\pm 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 most common anatomic variation was deviated nasal septum with 92.68% CT reported patients. This was followed by inferior turbinate hypertrophy, septal spur, concha bullosa, and agger nasi cells.

Conclusion: Computed tomography scan is considered the gold standard for sinonasal imaging. Diagnostic endoscopy and CT scan are 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. Computed tomography scan assists the surgeon as a "road map" during endoscopic sinus surgery.

Keywords: Anatomic variation, Chronic rhinosinusitis, CT scan, Nasal endoscopy.

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INTRODUCTION

Chronic rhinosinusitis (CRS) is one of the most 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.

Computed tomography (CT) scan had been well accepted as a mandatory prerequisite 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 has 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 recommend CT scan to form part of routine workup for CRS.

Nasal endoscopy plays a key role in identifying anatomical structural variations and mucosal changes of middle meatus and osteomeatal complex causing drainage block, leading to CRS both in patients with normal CT and in patients with abnormal scans. It was also noted earlier that there was close association between endoscopy and CT scan in the diagnostic work up of CRS. However, both nasal endoscopy and CT scan are performed to establish diagnosis in routine practice since the relative values of each have not been well established.

MATERIALS AND METHODS

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

The patients were clinically diagnosed as probable case of CRS and then subjected to the investigative

procedures: Diagnostic nasal endoscopy and CT scan. The endoscopy was done before the CT scan to avoid any observer bias. 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

- Patients attending the outpatient department (OPD) or admitted patients who were clinically diagnosed as CRS.
- Only those patients who gave full informed consent for the study were registered.
- 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 younger than 18 years.

Clinical diagnosis was based on subjective symptoms as defined by the 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.¹⁻³

The presenting symptoms are classified into major and minor symptoms according to the criteria.

Major Symptoms

Nasal obstruction/blockage

Nasal discharge/purulence/discolored postnasal discharge

Hyposmia/anosmia

Facial congestion/fullness

Facial pain/pressure (facial pain must be accompanied by another major factor to qualify for CRS).

Minor Symptoms

Fever

Halitosis

Headache

Cough

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 CRS.

Clinical Diagnostic Criteria of CRS Revision (2002 SAHP Task Force)³

- 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)
- One of these signs of inflammation in association with symptoms:
 - Discolored drainage, nasal polyp, or polypoid swelling on physical examination with anterior rhinoscopy or nasal endoscopy
 - Edema or erythema of middle meatus as identified by nasal endoscopy
 - Generalized edema, erythema, or granulation tissue (if it does not involve middle meatus or ethmoid bulla, radiological imaging is required).
 - 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. Magnetic resonance imaging scan is not recommended for routine diagnosis because of lack of specificity. The endoscopy of frontal recess, middle meatus, and sphenoethmoid recess was reviewed for presence of polyps, mucosal edema, congestion, discharge, scarring, or crusting.

Rigid nasal endoscopy was performed on all subjects under local anesthesia with topical application of 4% lidocaine hydrochloride and using 0 and 30° 4 mm diameter rigid nasal endoscope in accordance with SAHP Task Force criteria for defining adult CRS.³

All the assessments of CT and endoscopy were performed independently and assessors were blinded to each other's scores. The anatomical findings were assessed for every patient.

The data were tabulated and analyzed using the software program "Statistical Package for the Social Sciences" (SPSS) version 16. Sensitivity, specificity, and likelihood ratios were estimated for endoscopic diagnosis of CRS using CT scan as gold standard.

RESULTS

Only adults were included in the study. The mean age (standard error of the mean) of presentation was

Table 1: Comparison of anterior rhinoscopy and endoscopic findings

Parameters	Anterior rhinoscopy		Endoscopy	
	Number	Percentage	Number	Percentage
Deviated nasal septum	67	81.7	70	85.36
Inf. turbinate hypertrophy	45	54.87	45	54.87
Discharge in middle meatus	58	70.73	72	87.80
Middle turbinate hypertrophy	16	19.51	28	34.14
Paradoxical middle turbinate	10	12.1	3	3.65
Polyp/mass	1	1.21	4	4.8

34.11 (± 1.42) years, while most patients were from the age group of 18 to 30 years (Table 1). Males were predominating the study group with 62.2%, while 37.8% were females.

All the patients were initially examined clinically in the OPD along with proper history and provisionally diagnosed as cases of CRS. The clinical examination findings, that is, the findings of anterior rhinoscopy, were compared with that of the nasal endoscopic findings and are tabulated in Table 1. Most common finding both in anterior rhinoscopy and in nasal endoscopy was deviated nasal septum (DNS), followed by discharge in the middle meatus and inferior turbinate hypertrophy. There was a very good correlation in findings of DNS, inferior turbinate hypertrophy, while the findings of nasal purulence, middle turbinate hypertrophy, paradoxical middle turbinate, or presence of polyp were different.

Table 2 compares the CT scan and endoscopic findings with relation to anatomic variations. The parameters, such as DNS, septal spur, and inferior turbinate hypertrophy were comparable in both endoscopy and CT scan.

While the findings, such as concha bullosa and bent uncinata varied greatly, certain structures, such as onodi cells, haller cells, and agger nasi cells could not be visualized during diagnostic endoscopy.

Table 3 compares the pathological changes seen in the nasal cavity and paranasal sinuses as seen in CT and the nasal findings in endoscopy.

The involvement of sinuses as seen in the CT was noted. Most commonly affected sinus was maxillary sinus (68.29%) both as isolated involvement and in combination with other sinuses. This was followed by ethmoidal (53.65%), sphenoidal (34.14%), and frontal (26.82%) sinuses. Pansinusitis was found in 12.1% of patients.

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 a European study – the GA²LEN study.⁴ Computed tomography 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

Table 2: Anatomic variations of nose in the study subjects

Parameters	Endoscopic seen	Percentage	Computed tomography scan reported	Percentage
Deviated nasal septum	70	85.36	76	92.68
Septal spur	32	39.0	33	40.24
Inferior turbinate hypertrophy	55	67.07	47	57.31
Concha bullosa	8	9.75	25	30.48
Onodi cells	–	–	9	10.97
Haller cells	–	–	8	9.7
Agger nasi cells	–	–	22	26.82
Bent uncinata process	5	6.09	1	1.21
Paradoxical middle turbinate	6	7.3	12	14.63

Table 3: Pathological findings seen in the study subjects

Parameters	Computed tomography scan reported	Percentage	Endoscopic seen	Percentage
Polyp in middle meatus	9	10.97	4	4.8
Blocked hiatus semilunaris	28	34.14	22	26.82
Frontal recess block	10	12.19	–	–
Sphenoethmoid recess block	17	20.73	16	19.51
Discharge in middle meatus	–	–	72	87.80

In our study, age of patients varied among all adult age groups, with the maximum number of patients in the 18 to 30 years category. In the study conducted by Kirtane et al,¹⁰ the age ranged from 16 to 52 years with the maximum patients in the third decade. In our study, the majority of the patients (48.8%) were in the 18 to 30 years age group.

Anatomic variations in the lateral nasal wall are highly variable among different populations. Both CT scan and nasal endoscopy are very much essential in analyzing the anatomic variations.

We compare anatomical findings in CT scan of our study with that of the other past studies in Table 4.

As demonstrated in the table, in our study, concha bullosa was seen on CT examination in 25 (30.48%) cases, which is comparable to studies of Zinreich et al,¹¹ Shroff et al,¹⁶ and Wani et al.¹⁸

Controversially, in another study, it was said that DNS and concha bullosa are said not to have any significant correlation in the pathogenesis of CRS.¹⁹ But we found high prevalence of DNS among our patients (92.68% reported in CT scan).

The pneumatization of the middle turbinate (concha bullosa) may completely block the entrance to the middle meatus by creating an area of mucosal contact.²⁰ It has been implicated as a possible etiological factor in recurrent sinusitis due to its postulated negative influence on paranasal sinus ventilation.¹¹ Presence of concha bullosa is also a variable finding reported by Lloyd¹² in 14%, and Lloyd et al¹³ in 24% patients, Zinreich et al¹¹ in 36%, Asruddin et al¹⁴ in 28%.

Paradoxical middle turbinate may block the entrance to the middle meatus.²⁰ It is a very variable feature, Lloyd¹² reported it in 17% of cases, Asruddin et al in 12%,¹⁴ Zinreich et al¹¹ in 15%, Shroff et al in 16%, and Bolger et al in 6.1%. In our study, as demonstrated in the table, on CT scan, paradoxical bent middle turbinate was found in 14.63% cases, which is comparable to the study of Zinreich et al,¹¹ Lloyd et al,¹³ Shroff et al,¹⁶ and Asruddin et al.¹⁴

The uncinate process may be bent in two different directions. Its posterior margin may be deflected medially so that it approximates to the middle turbinate; or it may be laterally bent narrowing the hiatus semilunaris and the ethmoid infundibulum.¹² In our study, on the CT plate examination, the bent uncinate process was present in 1 of 82 cases. It is a variable finding. Lloyd reported its presence in 16% cases and the same author reported in another study done in 1991 its presence in 21% of the cases. Our result is comparable to the study of Asruddin et al,¹⁴ who obtained 2%.

Haller cells protrude from the floor of the 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.^{12,13} Thus, there is a wide variation in Haller cell frequency. Our findings were closer to Zinreich et al findings, who found Haller cells in 10% of cases.

Agger nasi cells on the lateral wall represent the most anterior of the anterior extra ethmoid air cells.²¹ In our study, agger nasi cells were present in 26.82% of the patients. The presence of agger nasi cells is a variable finding. Lloyd¹² reported its presence in 3% of the cases, while Maru et al found it in 88.5% of the cases.

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 the prevalence of DNS to be 80%, which was closer to our result than that of others.²³

Comparison of CT scan findings with respect to site of involvement of sinuses is noted in past studies in Table 5.

Only maxillary sinus involvement correlated well with the other two studies. In our study, we found that maxillary sinus is the most commonly afflicted sinus. Chronic rhinosinusitis usually involves multiple sinuses; in case of isolated sinus involvement, maxillary sinus once again is the commonest.

Table 4: Comparison of anatomic variations with previous studies

Anatomic variants	Zinreich et al ¹¹ (%)	Lloyd ¹² (%)	Lloyd et al ¹³ (%)	Asruddin et al ¹⁴ (%)	Bolger et al ¹⁵ (%)	Shroff et al ¹⁶ (%)	Maru and Gupta ¹⁷ (%)	Wani et al ¹⁸ (%)	Present study (%)
Concha bullosa	36	14	24	28	51	33	42.6	30	30.48
Deviated nasal septum	21	–	–	38	40	33	55.7	25.3	92.68
Paradoxical middle turbinate	15	17	15	12	6.1	16	9.8	9.33	14.63
Haller cell	10	2	15	28	5.1	6	36.1	8.66	9.7
Enlarged ethmoid bulla	8	17	18	9	–	8	–	–	–
Bent uncinate process	3	16	21	2	2.5	3	9.8	11	1.21
Agger nasi cell	–	3	14	48	–	9.8	88.5	9.33	26.82
Maxillary antrum septae	–	–	–	18	–	–	6.6	–	–

Table 5: Comparison of CT findings of sinus involvement with previous studies

Site of involvement		Maru and Gupta ¹⁷ (%)	Wani et al ¹⁸ (%)	Present study (%)
Ethmoid	Posterior	73.3	87.33	53.65
	Anterior	52.4	38	
Infundibulum/maxillary ostium		85	70	46.82
Maxillary antrum		70.4	65.33	68.29
Frontal		59	15	26.82
Sphenoid		51	8.66	34.14
Pansinusitis		–	–	12.1

CONCLUSION

- Anatomic variations of nose are highly variable, as suggested by previous studies.
- Deviated nasal septum and inferior turbinate hypertrophy are the commonest anatomical abnormalities in our study.
- Substantial number of patients had concha bullosa and agger nasi cells.
- Nasal endoscopy can effectively predict intrasinus involvement.
- Computerized tomography scan assists the surgeon as a “road map” during endoscopic sinus surgery.

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