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Diagnosis of Chronic Rhinosinusitis – CT Paranasal Sinus and Diagnostic Nasal Endoscopy: A Comparative Study

Authors
Peri Sreekavya[1], G.Raghunadha Babu[2], P.S.R.Rajeswari[3*], Kalyani Hanumanthu[4]
[1]Postgraduate, Department of Otorhinolaryngology and Head and Neck Surgery, Govt. ENT Hospital, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.
[2]Professor and Head of the Department, Department of Otorhinolaryngology and Head and Neck Surgery, Govt. ENT Hospital, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.
[3]Assistant Professor, Department of Otorhinolaryngology and Head and Neck Surgery, Govt. ENT Hospital, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.
[4]Postgraduate, Department of Otorhinolaryngologyand Head and Neck Surgery, Govt. ENT Hospital, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India
*Corresponding Author
P.S.R.Rajeswari

Abstract
Rhinitis and Sinusitis usually coexist and are concurrent in most individuals; thus, the correct terminology is now Rhinosinusitis. Most guidelines and expert panel documents now have adoptedthe term Rhinosinusitis instead of sinusitis. It is an inflammatory condition affecting thelining of the sinuses and nasal passages that can be variablein its clinical presentation. Proper diagnosis and classification of this disorder are important for effective management.
The Diagnosis of Chronic Rhinosinusitis based onvarious diagnostic modalities like CT PNS and Diagnostic Nasal endoscopy and their efficacy of precise diagnosis was evaluated. The accuracy was determined to assess the role of nasal endoscopy. Patients with age morethan 12 presenting for the assessment of chronicrhinosinusitis, not responding to medical treatment for more than 12 weeks, suffering from at least two or more of the symptoms like nasal obstruction, anterior or posteriornasal discharge, abnormalities of smell, and headache or facial pains were prospectively analyzed. All the selected patients were subjected to nasal endoscopy, followed by CTPNS. The Endoscopic findings were scored according to the Lund Kennedy scoring system. The CT PNS scans were scored according to the Lund Mackay scoring system.
The clinical diagnosis of CRS was determined based on the published sinusitis guideline criteria for adults, and the nasal endoscopic findings were compared with the diagnostic gold standard CT scan. A total of 100 patients were studied in this prospective hospital-based study.
Endoscopy was able to diagnose 84 % as CRS based on Lund–Kennedy score ≥ 2. 91 % patients could be labelled as CRS based on Lund–Mackey scores ≥ 4. On correlating the nasal endoscopy and CT PNS, it was found that sensitivity was 84.61 %, specificity was 22.22 %, PPV was 91.66 %, NPV was 12.5 %. The positive likelihood ratio of 1.08 and a negative likelihood ratio of 0.69 was found, and the p-value was found to be 0.1345, which confirms thatthere is no significant difference in diagnosing CRS by either modality. The addition of nasal endoscopy helps to reduce the use of CT, lowering costs, and radiation exposure.

Keywords: *Chronic rhinosinusitis (CRS), Diagnostic nasal endoscopy (DNE), Computed tomography of paranal sinuses (CT PNS).*

Introduction

Rhinosinusitis is a broad diagnostic term that encompasses a spectrum of disorders with inflammation of the mucosa of both the nasal cavity and paranasal sinuses. Past attempts at defining rhinosinusitis have been symptom-based [1,2]. Approximately 87 % of the patients attend the primary care setting for the diagnosis and management of rhinosinusitis, where nasal endoscopy and computed tomography (CT) imaging are not readily available[2]. Consequently, a majority of national and international consensus meetings have developed symptom-based definitions for the initial diagnosis of rhinosinusitis [3].

A study by the National Institute of Allergy and Infectious Diseases (NIAID) recently concludes that around 134 million Indians suffer from chronic rhinosinusitis, more than double the number of diabetic patients in India, causing significant personal and economic impact. Besides the enormous financial burden of CRS, there is also considerable patient morbidity in terms of quality of life caused by CRS as measured by various studies [3].

For proper diagnosis and management of CRS, in 2007, new guidelines for rhinosinusitis, from a multidisciplinary panel commissioned by the American Academy of Otolaryngology-Head and Neck surgery, were published. Instead of the 12 major and minor symptoms ofCRS, four specific symptoms, along with the documentation of middle meatal inflammation, to the diagnostic criteria for CRS in the hopes that objective data would improve diagnostic accuracy.

Twelve weeks or more of *two or more* of the following:

- Mucopurulent nasal discharge (anterior, posterior, or both)
- Nasal obstruction (mucosal congestion)
- Facial pain or feeling of fullness or
- Decreased sense of smell.

Furthermore, an *objective measure* for the diagnosis of CRS, i.e., mucosal inflammation documented by one or more of the following clinical findings:

- Purulent secretions or edema in the middle meatus or ethmoid region
- Polyps in the nasal cavity or the middle meatus with or without
- Radiographic imaging demonstrating inflammation ofthe paranasal sinuses.

This study mainly aims to assess the accuracy of objective diagnostic modality, namely nasal endoscopy and to compare with gold standard diagnostic modality, CT scan of the paranasal sinuses.

Materials and Methods

This study was conducted at Andhra Medical College, Visakhapatnam, from October 2018 to September 2019, for 12 months. One hundred adult patients attending ENT outpatient department, who were clinically diagnosed as CRS were included in the study. The diagnosis of CRS was based on the detailed history and clinical examination, those not responding to 12 weeks of medical management and suffering from at least 2 of the following symptoms (According to criteria described by AAO-HNS 2007), Nasal obstruction, Nasal discharge (anterior or posterior or both), Headache/facial pains, Abnormalities of smell.

Patients of pediatric age group, patients with a history of previous sinonasal

surgery, sinonasal malignancy, autoimmune disease, cystic fibrosis, suffering from any immunocompromised conditions, and those who declined to participate were excluded from the present study. All the subjects were evaluated by using the presence of two or more symptoms, nasal endoscopy, and CT paranasal sinus.

According to the guideline recommendation, the patient met symptom criteria for CRS if two or more sinonasal symptoms were positive. As per protocol, nasal endoscopy was performed with a 0 degree and 30-degree rigid endoscope. First, the endoscope was passed without decongestion or anesthesia to look for the status ofthe mucosa. Later, under topical anesthesia, DNE was

performed with a Zero degree and Thirty-degree rigid endoscopes. The presence or absence of mucosal edema, watery or purulent discharge and polypi was recorded. The findings were then quantified using the Lund–Kennedy scoring system[6], and the anatomical variations, if present, were noted. Each patient was then prepared for a CT scan.

During DNE, all the secretions were suctioned, decongestion was done, and then the patient was sent for CT PNS within a week. Plain CT scan of paranasal sinuses, axial and coronal cut, with saggital reconstruction, was done. All the anatomical variations were noted, andeach patient's scan was then staged using the Lund Mackay CT scoring system[5]. The diagnostic evidence of CRS was defined by a Lund Mackay score greater than or equal to 4[4].

Data for anatomical variations, endoscopic findings, and CT scores were tabulated in Excel (Microsoft) and imported into SPSS software version 17.0, and then statistical analyses for sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio, negative likelihood ratio, p-value, at 95 % confidence interval were performed to evaluate the accuracy of diagnostic nasal endoscopy and CT paranasal sinuses, in diagnosing CRS.

Results

A total of 100 patients were studied. Age range 16–60 years, mean age 30.2 years, standard deviation 12.3. The study group had a male preponderance with 65%. The percentage of patients reporting positive symptoms for *nasal obstruction/congestion, anterior and/or posterior nasal discharge, headache or facial pain/ pressure, and dysosmia* were 94, 76, 71, and 44 %, respectively.

Table 1 Percentage Distribution of the Positive Symptoms

Positive symptoms	Percentage (%)
Nasal obstruction/congestion	94
Anterior and/or posterior nasal discharge	76
Headache or facial pain/pressure	71
Dysosmia	44

Among those patients with *Positive Nasal Endoscopy findings*, *edematous mucosa* was seen in 54 % subjects, mild edema in 16 %, and severe edema in 38% subjects.

The discharge was seen in middle meatus in 55 %; on right side discharge was seen in 11 %, on the left side discharge was seen in 20 %, the bilateral discharge was seen in 24 %. 28 % of subjects had clear and thin discharge, while 27 % had a purulent discharge.

4 % *polypi* were seen on the right, 6 % on left and bilateral in 21 %, with a total of 31 % subjects having polypi. 7 % of subjects had polyp confined to the middle meatus, and 24 % had polyp beyond the middle meatus.

According to *Lund–Kennedy scoring system*, 16 % of subjects had scores<2, 47 % had scoresbetween 2 and 4, 26 % had scores between 5 and 8, and only 11 % subjects had a score between 9 and 12. The mean score was 5.2 and range 0–12.

Various anatomical variations seen on nasal endoscopy were septal deviation (causing obstruction) 84%, agger nasi 15 %, paradoxical middle turbinate 18 %, concha bullosa 48 %, accessory maxillary ostium 12 %, uncinate process hypertrophy 6 % and enlarged bulla ethmoidalis 14 %, inferior turbinate hypertrophy 74%.

In the present study, on studying the CT scans, 52 % had osteomeatal complex opacification, 82.25 % maxillary sinus haziness, 64.5 % anterior ethmoid sinus haziness, 32.25 % posterior ethmoid sinus haziness, 44.5 % frontal sinus haziness and 28 %sphenoid sinus haziness.

Among the anatomical variations on CT scans,

84% had septal deviation and/or spur, 31 % right, 35 % left, 18 % S shaped/deviation on one side and spur on the other side.

31 % have polyp, 5 % right, 9 % left, 17 % bilateral.

12 % accessory maxillary ostium, 3 % right, 3 % left, 6 % bilateral.

21 % Agger nasi, 6 % right, 10 % left, 5 % bilateral.

62 % concha bullosa, 16 % right, 20 % left, 26 % bilateral.
26 % paradoxical middle turbinate, 12 % right, 5 % left, 9 % bilateral
16 % pneumatised uncinate process, 4 % right, 6 % left, 6 % bilateral.
28 % over pneumatised ethmoid bulla, 13 % right, 10 % left, 5 % bilateral.
8 % Haller cells, 2 % right, 3 % left, 3 % bilateral.
5 % Onodi cells, 1 % right, 3 % left, 2 % bilateral.
80% inferior turbinate hypertrophy, 22% right, 16% left, 42% bilateral.
32% hypoplastic frontal sinus, 8% right, 14% left, 10% bilateral.

Table 2. Percentage Distribution of the various Anatomical variants found on CT PNS

CT Findings – anatomical variants	Right (%)	Left (%)	Bilateral (%)	Total (%)
Septal deviation	31	35	18 (S shaped)	84
Polyp	5	9	17	31
Accessory Maxillary Ostium	3	3	6	12
Agger nasi	6	10	5	21
Concha bullosa	16	20	26	62
Paradoxical middle turbinate	12	5	9	26
Over pneumatised Ethmoid Bulla	13	10	5	28
Haller cells	2	3	3	8
Onodicell	1	3	2	5
Inferior turbinate hypertrophy	22	16	42	80
Hypoplastic Frontal Sinus	8	14	10	32

On scoring according to *Lund Mackay scoring of CTPNS*, 24 % subjects had scores between 0 and 4, of which 9 % had scores less than 4, 29 % had scores between 5 and 8, 22 % had scores between 9 and 12, 17 % subjects had score between 13 and 16, and only 8 % each had scores between 17–20 and 20–24. The mean score was 10.4 and range 0–24.

On comparing CT and Endoscopy, septal deviation/spur was found in 84 %, polypi in 31 %, and accessory maxillary ostium 12 % each on endoscopy and CT. Agger nasi15 % on endoscopy, 21 % on CT; Paradoxical Middle turbinate 18 % on endoscopy and 26 % on CT, Conchabullosa 48 % on endoscopy, and 62 % on CT, large bullaethmoidalis 14 % on endoscopy and 28 % on CT.

84 % of Patients had Lund–Kennedy score >2 and 16 % had <2. 84 % of patients were diagnosed as CRS on endoscopy, and 16 % not diagnosed on endoscopy.

91 % of Patients had Lund–Mackayscore >4, and 9 % had <4.91 % of patients were diagnosed as CRS on CT scan, and 9 % not diagnosed on CT scan.

84 % of Patients were diagnosed on endoscopy, and 91 % of patients were diagnosed on CT scans. 16 and 9 % of patients each were not diagnosed on endoscopy and CT scans, respectively.

Table 3. Comparison between the Nasal Endoscopy and CT PNS – Percentage Distribution

Criteria	DNE	CT PNS
Septal deviation/spur	84 %	84 %
Polypi	31 %	31 %
Accessory Maxillary Ostium	12 %	12 %
Agger nasi	15 %	21 %
Paradoxical Middleturbinate	18 %	26 %
Conchabullosa	48 %	62 %
Large bullaethmoidalis	14 %	28 %
CRS DIAGNOSIS	*84%*	*91%*

Considering the CT scan as a gold standard, the accuracy of nasal endoscopy was calculated.

The sensitivity of nasal endoscopy is 84.61 %; that is, the probability of diagnosing CRS when itis present is 84.61%, but specificity is low22.2 %; that is, it is unable to exclude the disease.

The positive predictive value is 91.66 %, which means that 91.66 % of patients have a probability that the disease may present when the test is positive.

The negative predictive value is 12.5 %, which means that when the test is negative,12.5% of patients have the probability of not having the disease.

The positive likelihood ratio is 1.08, and the negative likelihood ratio is 0.69, therefore indicating that there is a high correlation between CT scan and endoscopic findings.

The p-value was 0.1345,which is in significant, indicating there is no significant difference in diagnosing CRSby endoscopy or CT scan.

Table 4. Percentage Distribution of the Statistical Analysis of the Nasal Endoscopy in Comparison to Gold Standard CT PNS

Statistical analysis	Observed values
Sensitivity	84.61 %
Specificity	22.2%
Positive predictive value (PPV)	91.66%
Negative predictive value (NPV)	12.5%
Positive likelihood ratio	1.08
Negative likelihoodratio	0.69
P-value	0.1345

Discussion

The diagnostic utility of nasal endoscopy, to standard clinical and radiologic criteria, has been assessed in relatively few clinical studies.

In 1997 a study by *Benninger et al.* evaluated the role of nasal endoscopy in the diagnosis and treatment planning in 100 consecutivepatients with sinonasal complaints. In this study, all diagnoses were made based on history and physical examination that included anterior rhinoscopy. Out of 100 patients, only 28 were diagnosed as CRS. In this study, the role of endoscopy was to determine whether the endoscopic findings contradict the established diagnosis. The study did not compare the endoscopy with CT scan results. Though the addition of endoscopy did not change any of the diagnosis of CRS, the study concluded it to be useful inevaluating patients in whom anterior rhinoscopy is limited either by anatomic variants or in whom the diagnosisis not precise[3,9].

Rosbe et al. study in 1998 study prospectively compared the results of nasal endoscopy, CT scanning, and asymptom questionnaire to determine whether a combination of symptoms and nasal endoscopycould accurately predict the CRS diagnosis on CT in 92 consecutive patients referred for sinonasal symptoms. They obtained CT scans on all patients with positive or equivocal endoscopic findings for CRS. They noted that 91 % of patients with positive endoscopic findings had CT scan results consistent with CRS. Of the patients with nasal obstruction and a positive findingon nasal endoscopy, 100 % had CT findings consistent with CRS. This study did not calculate positive predictive values (PPVs) or negative predictive values (NPVs) for endoscopy as compared with CT results and concluded that combined with a symptom history; the nasal endoscopy canbea highly specific technique to predict the positive CT findings of CRS[3,10].

Stankiewicz and Chow's study in 2002 had 78 patients meeting the current symptom-based definition of CRS. They evaluated the relationship between symptom history, nasal endoscopy, and CT findings. Nasal endoscopy was demonstrated as positive for CRS if purulence,nasal polyps, or watery congested mucosa were present. Among 37 patients with positive CT findings, 17 and 20 patients had positive and negative endoscopic results, respectively. The analysis of endoscopy as compared to CT results was sensitivity 46 %, and specificity 86 %, PPV 74 %, and NPV 64 %. The negative endoscopic findings had a stronger association with CT findings, with a 78 % correlation with thenegative or minimal sinus disease on CT. The study did not compare the history and endoscopy with CT findings. There was a low correlationamong the subjective symptom-based criteria for CRS and Endoscopic and CT findings. The endoscopy has a high specificity as compared with CT results[3,7].

The above three studies had used the 1997 Rhinosinusitis Task Force (RSTF) criteria, which included a combination of 12 major and minor symptoms.

In 2010, *Bhattacharyya et al.* specifically evaluated the relationship between the

combination of 4-patient reported symptoms of CRS and specific findings on nasal endoscopy, middle meatal purulence, and/or polypiwith CT findings. The addition of the endoscopic findings to symptom criteria based on the AAO-HNS guidelines had significantly increased the overall accuracy to 69.1 from 42.8 %, and the Odds ratio to 4.6 from 1.1, as compared with CT results. The Nasal Endoscopy also improved the PPV from 39.9 to 66.0 %, and NPV from 62.5 to 70.3%. The most significant improvement was in specificity, which increased from 12.3 to 84.1 % after the addition of endoscopy. The study concluded that, in patients who met symptom criteriafor CRS, the addition of nasal endoscopy significantly improved diagnostic accuracy for CRS. It found that in select patients, endoscopy might help reduce CT utilizationin making the diagnosis of CRS[3,8].

In 2012, Ferguson et al. study evaluated associations between symptom-based criteria as well as specific findings of mucopurulence and CT results. They noted that the accuracy of subjective symptoms for predicting CRS on CT scans was low. However, the endoscopic finding of mucopurulent discharge was only present in patients withpositive CRS on CT scans, and never seen in those with negative CT results. The study did not analyze the PPV or NPV ofendoscopy compared with CT; the specificity of endoscopy was 100 %. The sensitivity was only 24 %. They concluded that the nasal endoscopy can confirm a CRS diagnosis,but cannot rule it out and that the CT should be performed in cases of suspected CRS[3,11].

In *Lohiya et al.* study, 2014, the nasal endoscopy was compared to a gold standard CT scan. The sensitivity 88.04 %, specificity 28.57 %, positive predictive value 94.19 %, negative predictivevalue 15.38 %, positive likelihood ratio 1.23, negative likelihood ratio 0.42, thereby showing that nasalendoscopy had high sensitivity for diagnosing the disease but not specific enough to refute the diagnosis. The high positive likelihood ratio of 1.23 and low negative likelihood ratio of 0.42was found, thereby showing that endoscopic and CT PNS findings are consistent with eachother in diagnosing most of the cases[3].

In the present study, endoscopy was compared to gold standard CT scan and the results were sensitivity 84.61%, specificity 22.22 %, positive predictive value 91.66 %, negative predictive value 12.5 %, positive likelihood ratio 1.08, negative likelihood ratio 0.69, thereby showing that nasalendoscopy had high sensitivity for diagnosing the diseasebut not specific enough to refute the diagnosis.

The high positive likelihood ratio of 1.08 and low negative likelihood ratio of 0.69 was found, thereby showing that endoscopic and CT PNS findings are consistent with eachother in diagnosing most of the cases, and these findings were consistent with the Lohiya et al. study.

Table 5. Comparison among various studies showing the role of Diagnostic Nasal Endoscopy and CT PNS in Diagnosing the Chronic Rhinosinusitis

Study	Year	No.	Statistical measure	Conclusions
Benninger et al.	1997	100	Proportion (11 %)	Endoscopy useful only when diagnosis unclear
Rosbe et al.	1998	92	Proportion (91 %)	High specificity of endoscopy
Stankiewicz et al.	2002	78	PPV (74 %), NPV (64 %), Sensitivity (46 %), Specificity (86 %),	High specificity of the endoscopy with a low correlation to subjective symptoms
Bhattacharyya et al.	2010	202	OR (4.6), PPV (66.0), NPV(70.3)	An addition of endoscopy to subjective symptoms greatly improved the diagnostic accuracy
Ferguson et al.	2012	125	Sensitivity (24 %), specificity (100 %)	High specificity and low sensitivity of the nasal endoscopy confirm the CRS diagnosis but doesn't rule out
Lohiya et al.	2014	100	Sensitivity (88.04 %), sensitivity(28.57 %), PPV (94.19 %), NPV(15.38 %), PLR (1.23), NLR (0.42), pvalue (0.10565)	High sensitivity and PPV makes endoscopy a diagnostic modality to accurately diagnose the disease but does not rule it out
Present study	2018	100	Sensitivity (84.61%),sensitivity(22.22 %), PPV (91.66 %), NPV(12.5 %), PLR (1.08), NLR (0.69), p value (0.1345)	High sensitivity and PPV of nasal endoscopy consistent with the previous studies makes it an accurate tool for the CRS diagnosis

PPV - positive predictive value, NPV - negative predictive value, OR - odds ratio

1. The proportion in Benninger et al. study means the percentage of patients in whom nasal endoscopy had a significant role in the evaluation of diagnosis when being added to the history and physical examination with anterior rhinoscopy
2. The proportion in Rosbe et al. study indicates the percentage of patients with positive endoscopy findings who also had computed tomography positive for CRS

In a study conducted by Bhattacharya et al. in 2010, considering the 2007 criteria for diagnosis, the symptoms were graded according to a six-point Likert-scaleas mild and moderate symptoms and then added advantage of endoscopy was determined. In the present study, the presence of 2 or more symptoms only according to the 2007 criteria was considered similar to the Lohiya et al. study.

While doing endoscopy, the Bhattacharya et al.only considered the presence of polypi or purulent discharge. They did not consider edema as it was thought to be subjective, whereas the Lund–Kennedy scoring system for diagnosing patients for CRS was used in the Lohiya et al. study and the present study.

The study by Bhattacharya et al., Lohiya et al. and the present study used Lund–Mackay system for diagnosis of CRS on CT scan. Bhattacharya et al. concluded that based on the AAO-HNS guidelines, the addition of endoscopy to symptom criteria significantly increased the accuracy to 69.1 from 42.8%, and the odds ratio to 4.6 from 1.1 when compared to CT results. The endoscopy had also increased the PPV to 66.0 from 39.9 %, and NPV to 70.3 from 62.5 %. The most dramatic improvement was observed in the specificity, which increased from 12.3 to 84.1 % after the addition of endoscopy.

Whereas in the present study, no controls were used, the edema of mucosa was considered a positive finding similar to the Lohiya et al. study. On comparison among both the studies, the sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, negative likelihood ratio to be 88.04, 28.57, 94.19,15.38 %, 1.23, 0.42, and 84.61, 22.22, 91.66, 12.5 %, 1.08, 0.69 in Lohiya et al. and the present study respectively. This concludes thatthe nasal endoscopy had a high sensitivity for diagnosing the disease.

Conclusion

The present study concludes that in patients who meet guideline symptom criteria for CRS, the addition of nasal endoscopy improves the diagnostic accuracy for CRS and should be emphasized as an early diagnostic tool in the clinical evaluation. It should be considered as an outpatient-based procedure and performed on all patients suspected of having CRS.

The Diagnostic nasal endoscopy helps reduce CT utilization, thus reducing the cost and radiation exposure in a large population being evaluated for CRS. Diagnostic endoscopy, a less expensive, easily accessible tool, offers an advantage in the diagnosis of CRS.

In patients with poor or limited endoscopic visualization dueto polypi, or septal deviation or crowding of osteomeatal complex and presence of hidden air spaces like sphenoid sinus, ethmoid bulla, and posterior ethmoids, CT scan isuseful in discerning the disease.

Based on these findings from the study, if a patientmeets the guideline symptom criteria and has positive endoscopic findings, it would be reasonable totreat with aclinically presumed diagnosis of CRS before btaining a paranasal sinus CT scan. Sinusimaging couldbe considered for the patients with refractory symptoms despite maximal therapy and in those cases where surgery is being planned.

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