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The validity of clinical guidelines and nasal endoscopy in the diagnosis of chronic rhinosinusitis—a prospective observational study

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Abstract

Background Chronic rhinosinusitis is a common disease entity seen by ENT surgeons as well as general practitioners all over the world. This study is aimed to evaluate and validate whether the clinical guideline symptoms (set by AAO-HNS 2015) alone and/or nasal endoscopic findings can predict the diagnosis of CRS, taking CT as the gold standard.

Methods A total of 118 patients with symptoms of chronic rhinosinusitis were taken. They were divided into two groups on the basis of whether they fulfilled the Guideline symptom criteria laid down by AAO-HNS in 2015 for diagnosing chronic rhinosinusitis. Each group underwent diagnostic nasal endoscopy (DNE), and patients with either purulence, edema in the middle meatus or ethmoid, and polyps in the nasal cavity or middle meatus were considered positive for DNE. A Lund-Mackay CT score of > 4 was considered diagnostic of CRS. Each group was analyzed separately. Sensitivity, specificity, and positive predictive value of guideline symptom with and without the addition of nasal endoscopy was recorded taking CT as the gold standard.

Results Nasal obstruction was the most common seen in all cases (100%) followed by headache in 45 (38.1%), facial pain in 32 (27.1%), anterior nasal discharge in 28 (23.7%), decreased sense of smell in 22 (18.6%), and posterior nasal discharge in 19 (16.1%). Two-thirds of patients (78, 66.1%) fulfilled the clinical guideline symptoms criteria, and one-third of patients (40, 33.9%) did not fulfill the clinical guideline symptoms criteria. A positive finding on DNE was found in 59.3% ($n = 70$) of patients. More than half of patients (62, 52.5%) had mild grade on endoscopic examination, while only 8 (6.8%) had moderate grade, and none had severe grade. Guideline symptoms have a high sensitivity (80%) but a low specificity (50.94%) in the diagnosis of CRS, with a fair level of agreement with CT diagnosis (Kappa = 0.32). DNE has a moderate sensitivity (72.31%) but a low specificity (56.60%) in the diagnosis of CRS, with a fair level of agreement with CT diagnosis (Kappa = 0.29). Sensitivity and specificity were 80.77% and 57.69% respectively when guideline symptoms and DNE findings are taken in series.

Conclusion We conclude that neither Guideline Symptom Criteria nor DNE is independently sufficient enough to have a high diagnostic accuracy for CRS. Comparing the diagnostic efficiency among various modalities, we report that in patients who meet guideline symptom criteria for CRS, the addition of nasal endoscopy turned out to be

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a cost-effective diagnostic approach and improves the diagnostic accuracy of DNE for CRS reasonably, hence should be emphasized as a diagnostic tool in the evaluation of patients for CRS.

Keywords CRS, AAO-HNS 2015, Guideline symptom, Nasal endoscopy, Lund-Mackay, NCCT, Sensitivity, Specificity

Background

Chronic rhinosinusitis (CRS) has been considered a spectrum of disease entities which brings significant health and socioeconomic burden to large populations of people all over the world.

CRS has a lifetime prevalence of 15% and around 1 in 8 Indians suffer from CRS [1, 2].

In 1997, major and minor factors were laid for the diagnosis of chronic rhinosinusitis by AAO-HNS Multidisciplinary Rhinosinusitis Task Force (RSTF) meeting. Six major and seven minor factors were included, and chronic rhinosinusitis was considered to be present when > 2 major factors or 1 major + 2 minor symptoms were present [3, 4].

Reviews of these initial diagnostic criteria however demonstrated that symptoms alone do not correlate well with the objective radiographic evidence of the disease. Practically speaking, the combination of these major and minor symptoms was also somewhat cumbersome to operationalize in daily clinical practice.

In 2003, an attempt was made to modify the 1996 Task Force Guidelines by adding objective criteria to already existing major and minor criteria [5]. In 2007, new guidelines for CRS from a multidisciplinary panel commissioned by the American Academy of Otolaryngology, Head and Neck Surgery were published. These revised guidelines elaborated a more specific set of symptom criteria for the diagnosis of CRS, and the major and minor symptom categories were simplified into four symptoms [6].

These 2007 guidelines were updated in 2015 by the American Academy of Otolaryngology and Head & Neck Surgery (AAO-HNS) published in Otolaryngology Head and Neck Surgery 2015 [7]. Major and minor criteria which were replaced by four symptoms in 2007 guidelines were upheld by 2015 guidelines and were following 12 weeks or longer of 2 or more of the following signs and symptoms: mucopurulent drainage (anterior, posterior, or both); nasal obstruction (congestion); facial pain–pressure–fullness; decreased sense of smell. Furthermore, an objective measure was required for the diagnosis of CRS. Inflammation documented by one or more of the following: purulent (not clear) mucus or edema in the middle meatus or ethmoid region; polyps in the nasal cavity or middle meatus and/or radiographic imaging demonstrating inflammation of the paranasal sinuses.

This 2015 update provides evidence-based recommendations to manage adult rhinosinusitis but does not change the 2007 clinical guidelines for the diagnosis of chronic rhinosinusitis. According to the clinical practice guideline update, adult sinusitis 2015, statement 7B, "The clinician should confirm a clinical diagnosis of CRS with the objective documentation of sinonasal inflammation which may be accomplished using anterior Rhinoscopy, nasal endoscopy or computed tomography, a strong recommendation based on cross-sectional studies with preponderance of benefit over harm." The purpose of this statement is to strongly emphasize that requiring objective signs of inflammation increases diagnostic accuracy of CRS and serves to limit over-diagnosis [7].

Direct visualization of sinonasal mucosa at its most refined state is performed by nasal endoscopy. Findings on a nasal endoscopy that support a diagnosis of CRS include purulent mucus or edema in the middle meatus or ethmoid region or polyps in the nasal cavity or middle meatus. Many scoring systems like the Lund-Kennedy endoscopic system; Modified Lund-Kennedy endoscopic system; Discharge, inflammation, polyp (DIP) scoring system; and Perioperative sinus Endoscopic scoring system (POSE) are available to assess the severity of chronic rhinosinusitis [8].

Lund-Kennedy endoscopic scoring system was introduced in 1995 for the assessment of patients with CRS. It was designed for use in patients who had already undergone endoscopic sinus surgery but was frequently used in routine practice for assessment of CRS.

The Lund-Kennedy scoring system was modified by Psaltis et al. [8] in 2014 whereby they deleted scarring and crusting from the Lund-Kennedy scoring system. The Modified Lund-Kennedy scoring system improved upon the Lund-Kennedy scoring system in its reliability and clinical correlation with PROM (patient-reported outcome measures) like VAS and SNOT22, particularly in unoperated cases [8].

Computed tomography (CT) scan is the gold standard in the diagnosis of CRS. It can help to quantify the extent of inflammatory disease based on opacification of paranasal sinuses and improves the diagnostic accuracy. Mucosal abnormalities, sinus osteal obstruction, anatomic variants, and sinonasal polyposis are best displayed on CT scans. Various CT staging systems have been proposed to quantify the severity of CRS which include the following: The Lund-Mackay scoring [9], Friedman

and associates [10], Kennedy [11], Gliklich and Metson (Harvard System) [12]. The Lund-Mackay scoring is a widely used method for CT staging of CRS owing to its simplicity as well as its excellent inter-observer and intra-observer agreement. Notably, the Lund-Mackay system is the only system that has been recommended by the task force on rhinosinusitis for outcome research.

CT scan findings are graded by Lund-Mackay scoring. A score of > 4 is considered diagnostic of CRS [9, 13].

There is a paucity of literature on whether guideline symptoms and nasal endoscopy findings as laid down by AAO-HNS in 2015 can actually predict the diagnosis of chronic rhinosinusitis.

Besides this, primary care physicians treat the patients only on the basis of symptoms and reserve nasal endoscopy/NCCT for specialists.

Hence, this study is aimed to evaluate and validate whether the clinical guideline symptoms (set by AAO-HNS 2015) alone and/or nasal endoscopic findings can predict the diagnosis of CRS, taking CT as the gold standard.

Methods

The present prospective observational study was conducted in the Post Graduate Department of Otorhinolaryngology and Head and Neck Surgery (ORL AND HNS) from May 2020 up to October 2021 on patients attending the OPD of the Department with symptoms of chronic rhinosinusitis (CRS).

Inclusion criteria:

1. Patients > 18 years of age
2. Patients of both the sexes
3. Patients needing evaluation for chronic rhinosinusitis having some of the following symptoms for > 12 weeks: mucopurulent drainage (anterior, posterior, or both); nasal obstruction (congestion); facial pain–pressure–fullness; decreased sense of smell; headache; halitosis; fatigue; dental pain; cough; ear pain/pressure/fullness

Exclusion criteria:

1. Patients who have undergone nasal / sinus surgery.
2. Patients with autoimmune disorders
3. Immunocompromised patients
4. Patients currently on antibiotics/steroid/decongestants
5. Patients with acute rhinosinusitis

After taking an informed written consent, such cases were screened for inclusion and exclusion criteria. Only those patients who gave the consent and fulfilled the criteria were taken into the study. Thus, a total of 118 patients were taken for the study.

Ethical clearance was obtained from the Institutional Ethical Committee of Government Medical College Srinagar, before the start of the study.

The patients selected for our study were categorized into two groups based on whether they fulfill the symptom criteria laid down by clinical practice guidelines set by AAO-HNS in 2015.

Symptom criteria in guidelines are 12 weeks or longer of 2 or more of the following signs and symptoms:

1. Mucopurulent drainage (anterior, posterior, or both)
2. Nasal obstruction (congestion)
3. Facial pain–pressure–fullness
4. Decreased sense of smell

Depending upon whether the patients fulfilled the symptom criteria in guidelines, they were divided into two groups:

Group 1: Patients who fulfilled the symptoms criteria laid down by AAO-HNS 2015 guidelines.
Group 2: Patients who did not fulfill the symptoms criteria laid down by AAO-HNS 2015 guidelines.

Patients in each group were subjected to diagnostic nasal endoscopy (DNE) by 0-degree 4 mm/2.7 mm rigid endoscope under topical anesthesia without the use of local vasoconstrictors.

The presence or absence of the following signs was noted: purulence, edema in the middle meatus or ethmoid, polyps in the nasal cavity or middle meatus.

Endoscopic findings were recorded, and the endoscopic findings were graded by the Modified Lund-Kennedy endoscopic scores (Table 1). The endoscopist was blinded to the group allotted to the patient.

On the basis of DNE, patients in each group were further divided into two sub-groups: (1) those who had finding suggestive of CRS on DNE, either of (polyp/edema/discharge) and (2) those who did not have.

Each patient from each group was subjected to non-contrast computed tomography of nose and paranasal sinuses in both axial and coronal planes with slice thickness of 3 mm using Siemen 16 Slice Somatom Emotion machine (Siemens Healthcare, Forchheim, Germany) with the aim of documenting the inflammatory pathology. CT scan findings were graded by Lund-Mackay CT score. Lund-Mackay score of > 4 was considered diagnostic of CRS.

Categorical variables were described as frequencies and percentages. Continuous variables were described

Table 1 Endoscopic scores in Modified Lund-Kennedy method

S No	Features	Right nasal cavity	Left nasal cavity
1	Polyp	0/1/2	0/1/2
2	Edema	0/1/2	0/1/2
3	Discharge	0/1/2	0/1/2
Total score can range from 0 to 12. Total score will be graded as follows: Mild 1–4, Moderate 5–8, Severe 9–12			
Findings	**Score = 0**	**Score = 1**	**Score = 2**
Polyp	No polyp	Polyp in middle meatus only	Beyond middle meatus
Edema of mucosa	Absent	Mild	Severe
Discharge	Absent	Clear, thin discharge	Thick, purulent discharge

as mean and standard deviation. The chi-square test was used to analyze the relationship between two categorical variables and *T*-test was used to compare continuous variable between two groups. Cohen's Kappa was calculated to assess the extent of agreement between two measurements. A p value of < 0.05 was considered statistically significant.

Results

The present study was undertaken in the Department of ENT & HNS, GMC Srinagar. The findings of the study are briefly summarized in a flow chart (Fig. 1).

Total number of patients taken for the study were 118. Males and females were almost equally distributed among the study participants with male to female ratio of 1.19:1.

Nasal obstruction was the most common seen in all cases (100%) followed by headache in 45 (38.1%), facial pain in 32 (27.1%), anterior nasal discharge in 28 (23.7%), decreased sense of smell in 22 (18.6%), and posterior nasal discharge in 19 (16.1%).

Two-thirds of patients (78, 66.1%) fulfilled the clinical guideline symptoms criteria, and one-third of patients (40, 33.9%) did not fulfill the clinical guideline symptoms criteria. A positive finding on DNE was found in 59.3% (n = 70) of patients.

More than half of patients (62, 52.5%) had mild grade on endoscopic examination, while only 8 (6.8%) had moderate grade and none had severe grade.

CT scan positive rate in the total study population is 55.1%, in the study population not fulfilling the Guideline Symptom Criteria is 32.5% (13/40), and in the study population fulfilling the Guideline Symptom Criteria is 66.7% (52/78). This implies that CT scan positive rate is higher in the study subjects fulfilling Guideline Symptom Criteria.

The percentage of positive endoscopy is higher (67.95%) in subjects fulfilling Guideline symptom criteria than those not fulfilling Guideline symptom criteria (42.5%) with the value of Kappa 0.24.

Guideline Symptoms have a high sensitivity (80%) but a low specificity (50.94%) in the diagnosis of CRS, with a fair level of agreement with CT diagnosis (Kappa = 0.32) (Table 2).

DNE has a moderate sensitivity (72.31%) but a low specificity (56.60%) in the diagnosis of CRS, with a fair level of agreement with CT diagnosis (Kappa = 0.29) (Table 3).

Sensitivity and specificity were 80.77% and 57.69% respectively when Guideline symptoms and DNE findings are taken in series (Table 4).

Guideline Symptom Criteria Plus Nasal Endoscopy, when used simultaneously, in the diagnosis of CRS, has a low sensitivity 64.62% but a high specificity 79.25%, a high diagnostic accuracy 71.19%, and a moderate level of agreement (Kappa = 0.43) (Table 5).

Guideline Symptom Criteria Plus Nasal Endoscopy, when used simultaneously, in the diagnosis of CRS and only those study subjects considered positive or negative who have both the results either positive or negative. Such diagnosis has a high sensitivity 84% but a low specificity 57.69%, a high diagnostic accuracy 75%, and a moderate level of agreement (Kappa = 0.43) (Table 6).

So, taking all findings together Guideline Symptom Criteria and DNE in Parallel 2 has the highest sensitivity (84%), while Guideline Symptom Criteria and DNE in Parallel 1 has the highest specificity (79.25%) (Table 7).

On diagnostic nasal endoscopy (DNE), the most common finding was edema (present in 38.14% of patients), followed by discharge (22.03%) and polyp (16.10%).

The chances of CRS on CT are higher among those study subjects who have a polyp on DNE, and this association is statistically significant with a p value of < 0.001.

As the grade of MLK on DNE increases from mild to moderate, the percentage of patients with CRS on CT increases, and this association is statistically significant with a p value of 0.001.

The presence of anterior nasal discharge and decreased sense of smell was associated with a higher

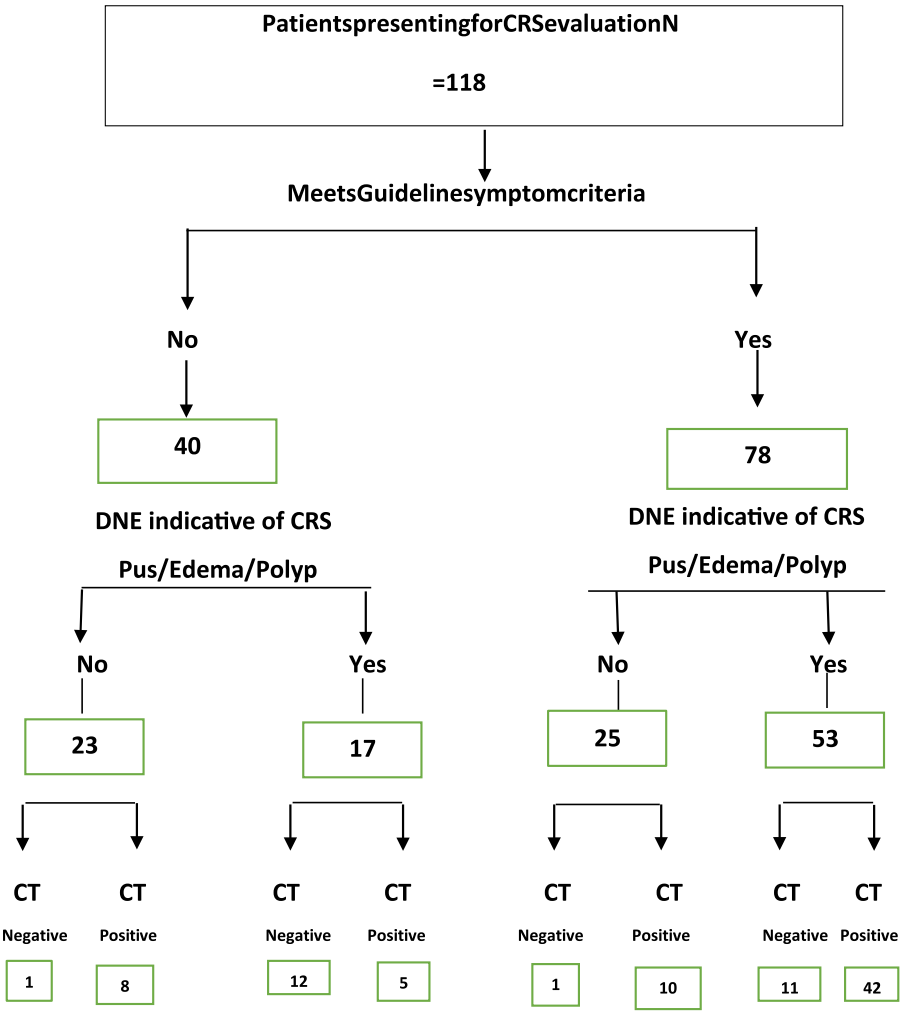

Fig. 1 Flowchart depicts the distribution of study patients

Table 2 Comparison between Guideline Symptom Criteria and CT diagnosis (LM score ≥ 4) among study subjects and diagnostic utility of Guideline Symptom Criteria in CRS againstCT

Guideline SymptomCriteria	**CT diagnosis**		**Total**
	CRS present	**CRS absent**	
Present	52	26	78
Absent	13	27	40
Total	65	53	118
Parameter	**Estimate**		**Lower–upper 95% Cis**
Sensitivity	80%		68.73–87.92
Specificity	50.94%		37.88–63.88
Positive predictive value	66.67%		55.64–76.13
Negative predictive value	67.50%		52.02–79.92
Diagnostic accuracy	66.95%		58.05–74.78
Likelihood ratio of a positive test	1.631		1.498–1.775
Likelihood ratio of a negative test	0.3926		0.3149–0.4895
Diagnostic odds	4.154		1.844–9.357
Cohen's kappa	0.3166		0.1409–0.4923

Table 3 Comparison between DNE findings (pus/edema/polyp) and CT among study subjects and diagnostic utility of diagnostic nasal endoscopy in CRS against CT among study subjects

Nasal endoscopy	**CT diagnosis**		**Total**
	CRS present	**CRS absent**	
Positive	47	23	70
Negative	18	30	48
Total	65	53	118
Parameter	**Estimate**	**Lower–upper 95% CIs**	
Sensitivity	72.31%	(60.42, 81.71[1])	
Specificity	56.60%	(43.27, 69.05[1])	
Positive predictive value	67.14%	(55.5, 77[1])	
Negative predictive value	62.50%	(48.36, 74.78[1])	
Diagnostic accuracy	65.25%	(56.3, 73.24[1])	
Likelihood ratio of a positive test	1.666	(1.506–1.844)	
Likelihood ratio of a negative test	0.4892	(0.4173–0.5735)	
Diagnostic odds	3.406	(1.58–7.343)	
Cohen's kappa	0.2917	(0.1119–0.4714)	

Table 4 Comparison between DNE findings (pus/edema/polyp) and CT and diagnostic utility of nasal endoscopy in CRS against CT among patients who fulfill the Guideline Symptom Criteria (Guideline Symptom Criteria and DNE in series)

Nasal endoscopy	**CT diagnosis**		**Total**
	CRS present	**CRS absent**	
Positive	42	11	53
Negative	10	15	25
Total	52	26	78
Parameter	**Estimate**		**Lower–upper 95% CIs**
Sensitivity	80.77%		(68.1, 89.2[1])
Specificity	57.69%		(38.95, 74.46[1])
Positive predictive value	79.25%		(66.54, 88[1])
Negative predictive value	60%		(40.74, 76.6[1])
Diagnostic accuracy	73.08%		(62.32, 81.66[1])
Likelihood ratio of a positive test	1.909		(1.58–2.307)
Likelihood ratio of a negative test	0.3333		(0.249–0.4463)
Diagnostic odds	5.727		(2.025–16.2)
Cohen's kappa (unweighted)	0.3883		(0.1665–0.6102)

chance of CRS, and these associations were statistically significant with p value of 0.05 and 0.03, respectively.

Discussion

The current observational study was undertaken for the evaluation of the validity of guideline symptoms set by AAO-HNS (2015), the accuracy of objective diagnostic modalities for chronic rhinosinusitis, and their comparison to each other to reach the correct diagnosis with the highest possible accuracy.

Subjects of both sexes, presenting for evaluation of chronic rhinosinusitis, were prospectively studied.

Among all the subjects, males showed an over-representation than females, i.e., males were 64 (54.2%) and females were 45.8%. The mean age of participants was 28.77 years with an SD of 10.57 years. Such male predominance has been seen in many studies like that of Devyani et al. [14] and Perez et al. [15]. Collins et al. [16] found that men were 2.5 times more likely than women to have been exposed to occupational dust or chemicals that might be accounting for their predominance. No convincing mechanisms or pathophysiological explanations have been offered so far for these gender-based differences.

Table 5 Comparison between Guideline Symptom Criteria Plus Nasal Endoscopy Diagnosis and CT diagnosis among study subjects and diagnostic utility of Guideline Symptom Criteria Plus Nasal Endoscopy, when used together, in the diagnosis of CRS (Guideline SymptomCriteria and DNE in Parallel 1)

Guideline symptoms and nasal endoscopy diagnosis	**CT diagnosis**		**Total**
	CRS present	**CRS absent**	
CRS Present (Guideline symptom criteria and DNE + ve)	42	11	53
CRS absent **(either GSC absent or DNE-ve or both-ve)**	23	42	65
Total	65	53	118
Parameter	**Estimate**	**Lower–upper 95% CIs**	
Sensitivity	64.62%	52.47–75.12	
Specificity	79.25%	66.54–88	
Positive predictive value	79.25%	66.54–88	
Negative predictive value	64.62%	52.47–75.12	
Diagnostic accuracy	71.19%	62.45–78.59	
Likelihood ratio of a positive test	3.113	2.539–3.817	
Likelihood ratio of a negative test	0.4465	0.4051–0.4922	
Diagnostic odds	6.972	3.022–16.09	
Cohen's kappa	0.4296	0.2529–0.6064	

Table 6 Comparison between Guideline Symptom Criteria Plus Nasal Endoscopy Diagnosis and CT diagnosis among study subjects and diagnostic utility of Guideline Symptom Criteria Plus Nasal Endoscopy, when used together, in the diagnosis of CRS (Guideline Symptom Criteria and DNE in Parallel 2)

Nasal endoscopy and guideline together	**CT diagnosis**		**Total**
	CRS present	**CRS absent**	
Positive **(GSC present and DNE + ve)**	42	11	53
Negative **(GSC absent and DNE-ve)**	8	15	23
Total	50	26	76
Parameter	**Estimate**	**Lower–upper 95% CIs**	
Sensitivity	84%	(71.49, 91.66)	
Specificity	57.69%	(38.95, 74.46)	
Positive predictive value	79.25%	(66.54, 88)	
Negative predictive value	65.22%	(44.89, 81.19)	
Diagnostic accuracy	75%	(64.22, 83.37)	
Likelihood ratio of a positive test	1.985	(1.647–2.394)	
Likelihood ratio of a negative test	0.2773	(0.1972–0.39)	
Diagnostic odds	7.159	(2.419–21.18)	
Cohen's kappa	0.4288	(0.2049–0.6527)	

Table 7 Comparison of diagnostic accuracy parameters among various diagnostic modalities

Diagnostic modality	**Sensitivity**	**Specificity**	**Diagnosti accuracy**
Guideline Symptom Criteria	80%	50.94%	66.95%
DNE	72.31%	56.60%	65.25%
Guideline Symptom Criteria and DNE in Series	80.77%	57.69%	73.08%
Guideline Symptom Criteria and DNE in Parallel 1	64.62%	79.25%	71.19%
Guideline Symptom Criteria and DNE in Parallel 2	84%	57.69%	75%

Nasal obstruction was the most common seen in all cases (100%) followed by headache in 45 (38.1%), facial pain in 32 (27.1%), anterior nasal discharge in 28 (23.7%), decreased sense of smell in 22 (18.6%), and posterior nasal discharge in 19 (16.1%). The presence of anterior nasal discharge and decreased sense of smell was associated with a higher chance of CRS, and these associations were statistically significant with p values of 0.05 and 0.03, respectively. EnemaJob Amodu et al. [17] and Jagram Verma et al. [18] in their studies also found nasal obstruction as the most common symptom. In fact, earlier studies have also reported nasal obstruction to be the main symptom presented by most of the patients with CRS [19]. The loss or reduction of sense of smell and posterior nasal discharge was reported by a smaller number of patients recruited in our study. In line with our results, earlier studies have also reported that only smaller percentage of subjects with CRS report loss of smell [20]. In contrast to our study, Kenny TJ. et al. [21] found sleep disturbance to be the most common symptom, while Arvind Reddy et al. [22] found headache as the most common symptom.

Guideline symptom criteria based on AAO-HNS guidelines (2015) were fulfilled by two-thirds of the subjects (66%, 78) in our study, and 34% (40) of the subjects did not fulfil the said criteria. In a similar study conducted by Bhattacharyya Lee et al. [23] who followed symptom guidelines criteria of 2007, 88% of patients met the guideline symptom criteria and 12% of patients did not. Darrat et al. [24] who also followed 2007 guidelines found a low percentage of patients (about 16%) meeting the guideline symptom criteria in their study.

In our study, out of 78 suspected patients of CRS who met the guideline symptom criteria only, two-thirds (66.67%; 52/78)) were confirmed to have CRS on CT, while one-third (33.33%) had no findings on CT and were overestimated as CRS. Similarly, the patients who did not meet the guideline symptom criteria included some cases of CRS as diagnosed on CT. Out of 40 patients who did not meet the guideline symptom criteria, 13 had CT findings suggestive of CRS and thus were missed while 27 had no CT findings. Thus, guideline symptoms had a moderate level of sensitivity (80%) but a low specificity (50.94%) in the diagnosis of CRS, with a low level of agreement (Kappa = 0.32), when compared with the gold standard diagnosis by CT.

The positive predictive value was 66.67%, and the negative predictive value was 67.5%, with a diagnostic accuracy of 66.95%. The likelihood ratio of positive test was 1.63 and that for a negative test was 0.39 and a diagnostic odds was 4.15.

All these diagnostic accuracy parameters suggest that guideline system criteria are not sufficient enough to label a suspected person as CRS because it misses some cases (11%, i.e., 13) out of 118 and also wrongly labels some as CRS (22%, i.e., 26 out of 118).

Similarly, the patients who had positive endoscopic results only two-thirds (67.14%) were confirmed to have CRS on CT, while around one-third, i.e., 32.86%, had no findings on CT.

Also, the patients who had negative endoscopic results included some cases of CRS as diagnosed on CT. Out of 48 patients who did not have any positive finding on nasal endoscopy, 13 had CT findings suggestive of CRS and thus were missed. Thus, the diagnostic nasal endoscopy has sensitivity of 72.31% and specificity of 56.60% in the diagnosis of CRS, with a low level of agreement (Kappa = 0.29) when compared with the gold standard diagnosis by CT. The positive predictive value was 67.14%, negative predictive value was 62.50% with a diagnostic accuracy of 65.25%, likelihood ratio of positive test was 1.66, and that for negative test was 0.49 and a diagnostic odds of 3.41. All these diagnostic accuracy parameters suggest that diagnostic nasal endoscopy is not single-handedly dependable enough to label a suspected person as CRS because it misses some cases (15.25%, 18 out of 118) and labels some patients as CRS who had no signs on CT scan (19.49%, 23 out of 118).

Once the diagnostic accuracy of nasal endoscopy was evaluated among those patients only who met the guideline symptom criteria, an appreciable improvement was observed. Almost all the perimeters improved. The observed values include sensitivity 80.77%, specificity 57.69%, Kappa 0.39, positive predictive value 79.25%, negative predictive value 60%, diagnostic accuracy 73.08%, likelihood ratio of positive test 1.91, likelihood ratio of negative test 0.33, and diagnostic odds 5.73. Bhattacharyya N et al. [23] conducted a similar study in 2010 in which 202 patients were studied. For symptom criteria alone, sensitivity, specificity, positive predictive value, and negative predictive value were 88.7%, 12.3%, 39.9%, and 62.5% respectively which are close to our values. The addition of nasal endoscopy findings to symptom criteria significantly improved specificity, positive predictive value, and negative predictive value to 84.1, 66.0, and 70.3% in their study, respectively. The odds ratio of true diagnosis of CRS improved from 1.1 to 4.6 (95% confidence interval, 2.3 to 9.2). They similarly concluded that in patients meeting the current guideline symptom criteria for CRS, the addition of nasal endoscopy improves diagnostic accuracy and should be emphasized as an early diagnostic tool. Diagnostic endoscopy may help to reduce the use of CT and reduce in cost and radiation exposure.

Kolethekhat AA et al. [25] in a study concluded that nasal endoscopy is a valid objective diagnostic tool in

the work-up of patients with symptomatic CRS. CT scan can be reserved as a second-line investigation for sub group of patients with negative endoscopy who remain symptomatic on follow-up. Lohiya SS et al. [26] in a study found that in patients who meet the guideline symptom criteria for CRS, the addition of nasal endoscopy improves diagnostic accuracy for CRS and should be emphasized as an early diagnostic tool in clinical evaluation. The addition of nasal endoscopy helps to reduce the use of CT, reducing cost and radiation exposure. In the light of these findings, they concluded that if a patient meets guideline symptom criteria with positive endoscopic findings, it would be reasonable to treat with a clinically presumed diagnosis of CRS before obtaining CT paranasal sinus.

Sinus imaging could then be considered for those patients with refractory symptoms despite maximum therapy and in those cases where surgery is being planned. Other studies in line with our observations are Tyagi S et al. [27], Ramadhan AK et al. [28], and Sriprakash V et al. [29].

If the results of the diagnostic nasal endoscopy and clinical guideline symptoms are considered in parallel, the diagnostic accuracy parameters improved. Thus, in this scenario, we are missing an even lesser no. of patients of CRS and also have a group of patients with equivocal diagnosis with either of the two (clinical guideline symptoms or DNE) negative which can be further confirmed by CT scan. This approach not only improves the diagnostic utility of nasal endoscopy but also decreases the utilization of CT scan thereby decreasing the cost and radiation exposure.

In our study, the most common nasal endoscopic finding was edema (in about 38% of subjects) followed by discharge (in 22% of subjects) and polyps (in 16% of subjects). The chances of CRS on CT are higher among those study subjects who have a polyp on DNE, and this association is statistically significant with a p value of < 0.001. As the MLK grade on DNE increases from mild to moderate, the percentage of patients with CRS on CT increases, and this association is statistically significant with a p value of 0.001. In an earlier study from North India by Nanda et al. [30], it was reported that on DNE in CRS patients, mucosal edema and mucopurulent discharge were seen in 78% of patients and nasal polyps in 35% of patients (50). Nangia et al. [31] in a similar study found that DNE edema and mucopurulent discharge were seen in equal distribution among the patients. Polyps were seen in the least number of their patients. Karthika Nathan et al. [19] in their study on CRS patient fulfilling 2007 symptom guidelines found polyps in 44 (55%), discharge in 37 patients (46.25%), and edema in 25 patients (31.25%).

Computed tomography (CT) scan is the gold standard in the diagnosis of CRS. It can help to quantify the extent of inflammatory disease based on the pacification of paranasal sinuses and improves the diagnostic accuracy. Mucosal abnormalities, sinus osteal obstruction, anatomic variants, and sinonasal polyposis are best displayed on CT scan. CT scan findings are graded by Lund-Mackay scoring. A score of ≥ 4 is considered diagnostic of CRS.

CRS on CT scan in our study was significantly associated with the symptoms of anterior nasal discharge and decreased sense of smell, and the association was found statistically significant.

Kenny TJ et al. [21] conducted a prospective study to determine whether there is a correlation between the severity of sinus symptoms and the severity of CT scan evidence of rhinosinusitis. They concluded that certainty of a clinical diagnosis of rhinosinusitis requiring treatment is enhanced in patients with sleep disturbance, nasal discharge, nasal blockage, or decreased sense of smell.

In order to diagnose chronic rhinosinusitis (CRS), diagnostic nasal endoscopy (DNE) and computed tomography (CT) scan both are important investigations. But both have their pros and cons; some findings are seen better on DNE and others on CT. Our study aimed to correlate DNE and CT findings and found a good amount of correlation if clinical guideline criteria is taken into consideration. Both DNE and CT scan should be used for planning the management of CRS efficiently. DNE tells better about middle meatal secretions, condition of mucosa, and polyps. But in situations where due to anatomical variation DNE is difficult, CT scan is helpful. Diagnostic endoscopy may help reduce the use of CT, reducing costs and radiation exposure to the patients.

Conclusion

We conclude that neither Guideline Symptom Criteria nor DNE is independently sufficient enough to have a high diagnostic accuracy for CRS. Comparing the diagnostic efficiency among various modalities, we report that in patients who meet guideline symptom criteria for CRS, the addition of nasal endoscopy turned out to be a cost-effective diagnostic approach and improves the diagnostic accuracy of DNE for CRS reasonably, hence should be emphasized as a diagnostic tool in the evaluation of patients for CRS. While CT scan is considered the gold standard for diagnosis of CRS, if the Guideline Symptom Criteria and DNE are used in parallel, they can yield better results and can avoid the CT induced radiation exposure besides minimizing cost, in the majority of patients, for proper diagnosis and subsequent therapeutic intervention.

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Authors' contributions
MA collected, recorded, and analyzed the data. SA did endoscopies for the patient and at the end contributed in the data collection and analysis. RH did statistical analysis. ML helped in the preparation of the manuscript and did overall supervision in this study. SAS also helped in preparation of manuscript and did supervision in this study.

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Availability of data and materials
All data generated or analyzed during this study are available from the corresponding author on reasonable request**.**

Declarations

Ethics approval and consent to participate
The study was approved by Ethical committee of Government Medical College Srinagar, JK, India. All patients consented to the participation of this study.

Consent for publication
Verbal consent was taken from patients enrolled in the study.

Competing interests
The authors declare that they have no competing interests.

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