Diagnostic Accuracy of Nasal Endoscopy as Compared to Computed Tomography in Chronic Rhinosinusitis

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Abstract The study was done with the aims to evaluate the accuracy of nasal endoscopy as compared to computed tomography (CT) in diagnosing chronic rhinosinusitis (CRS) and to evaluate the correlation between Endoscopy Score and CT Score. It was a cross sectional study. Every consecutive, symptomatic patient of CRS who fulfilled the criteria of American Academy of Otolaryngology—Head and Neck Surgery Task Force were included in the study. Rigid diagnostic nasal endoscopy (DNE) was done and Lund-Kennedy scoring system was used. Plain CT of paranasal sinuses was done on the same day and severity was assessed using Lund-Mackay scoring system. Results were analysed considering CT as a gold standard. Out of 54 study patients, 45 (83.33%) had abnormal endoscopic examination while 50 (92.59%) were showing positive CT scan. Sensitivity and specificity of DNE against CT scan were 94% (95% CI 81.43–98.33%) and 75% (95% CI 42–99.24%), respectively. The positive predictive value was 98% and negative predictive value was 67%. Correlation between Lund-Mackay overall CT and Lund-Kennedy Endoscopy Score was high [Pearson's correlation coefficient (r) = 0.881, p value < 0.0001]. The conclusion was drawn that, endoscopy is valuable in individuals with symptoms consistent with CRS and can be used to confirm the diagnosis and to know the severity of the disease. CT scan can be advised in those with high clinical suspicion of CRS but negative endoscopy and in those having persistent

symptoms after optimum medical management requiring Functional Endoscopic Sinus Surgery.

Keywords Chronic rhinosinusitis · Nasal endoscopy · Computed tomography · Paranasal sinus

Introduction

Chronic rhinosinusitis (CRS) is a common disease that affects the quality of life and causes considerable treatment costs. Although it is a frequently encountered disease affecting nearly 50 million individuals every year, its diagnosis and treatment still poses a challenge [1].

In medicine, diagnosis is an important aspect to get a clue to cure the disease. In 1997, criteria for diagnosis of CRS were developed by American academy of Otorhinolaryngology—Head and Neck Surgery (AAO-HNS). According to the guidelines of AAO-HNS published in 2007, a combination of symptom criteria and objective findings are required for the diagnosis of CRS. A positive diagnosis of CRS was defined as complaints of 2 or more major criteria or 1 major criteria and 2 or more minor criteria lasting for 12 weeks or longer. In addition, objective measures, such as evidence of nasal polyps or purulent mucus in the middle meatus or ethmoid region on nasal endoscopy, or radiographic evidence of paranasal sinus inflammation are also recommended [2–4].

Computed tomography (CT) scan plays a vital role in the diagnosis of CRS and in detecting its complications. It has the ability to detect mucosal disease and anatomical variations, to demonstrate a primary obstructive pathology and to visualise posterior ethmoid, sphenoid sinuses and thus helps in the management of CRS. Nasal endoscopy helps in evaluation of the osteomeatal complex for

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evidence of the disease and to detect anatomical defects that compromise ventilation and mucociliary clearance. Hence nasal endoscopy and CT have brought the revolution in understanding CRS and are the prerequisites for Functional Endoscopic Sinus Surgery.

The CT scan is considered as a gold standard diagnostic test for CRS [5, 6]. Its sensitivity and specificity is more than plain film radiography [7]. But performing CT scan just to confirm CRS preoperatively unnecessarily increases the risk of exposure to ionizing radiation, also adds cost of procedure. Hence this study was undertaken to evaluate whether nasal endoscopy can help in reducing rate of CT in diagnosis of CRS and can be advised only in specific patients.

Aims and Objectives

1. To evaluate the accuracy of nasal endoscopy as compared to CT in diagnosing CRS.
2. To evaluate the correlation between Endoscopy Score and CT Score.

Materials and Methods

This was a cross sectional study, conducted over a period of 2 years during Jan 2013–Dec 2015, in the Department of Otorhinolaryngology, of a Tertiary Teaching Hospital in Central India. Institutional Ethics Committee approval was obtained beforehand. Informed written consent was obtained from all the participating patients. Every Consecutive patient of CRS was diagnosed as per the criteria of Task Force on Rhinosinusitis [2–4] i.e. those patients who presented with 2 or more major criteria or 1 major criteria and 2 or more minor criteria were enrolled into the study. Patients with acute rhinosinusitis, those with of sinusitis of dental origin, past history of facial trauma or any sino-nasal surgery, tumour of paranasal sinus and patients of age below 15 years were excluded from the study.

After detail history, clinical examination and routine laboratory investigations, cases were subjected to diagnostic nasal endoscopy (DNE) and computed tomography (CT) of nose and para nasal sinuses (PNS) on the same day. Rigid nasal endoscopy was performed in all subjects under local anaesthesia with topical application of 2% xylocaine and using 0° and 30°, 4 mm diameter rigid nasal endoscope (Scholley, Germany). Nasal endoscopy was done by using the standard three pass technique as described by Kennedy [8]. Nasal endoscopy findings were noted using Lund-Kennedy Endoscopic Scoring system [9] to assess the following parameters: nasal mucosa oedema (absent = 0,

mild-moderate = 1 or polypoid degeneration = 2), presence of secretion (absent = 0, hyaline = 1 or thick and/or mucopurulent = 2) and presence of polyps (absent = 0, limited to the middle meatus = 1 or extended to the nasal cavity = 2). The assessment was performed bilaterally, with the total points corresponding to the sum of values obtained in both sides total score > 2 was considered as positive.

Plain CT Scan Nose and PNS was done in all cases included in the study. Scanning was done on Toshiba Spiral CT scanner with patient in supine position with head extension. Patient in whom head extension was contraindicated due to cervical spondylosis, Gantry tilt was suitably adjusted. The images were obtained in Axial and Coronal planes with reconstruction in Sagittal images using the raw data. Thickness of sections was 3 mm at Osteomeatal Complex and 5 mm for rest of the structures with same shift to get continuous sections. CT scan was done for both bony and soft tissue windows. Lund-Mackay scoring system was used to assess involvement of the maxillary, anterior ethmoid, posterior ethmoid, sphenoid and frontal sinuses as the follows: 0-no opacification, 1-partial opacification, 2-complete opacification. Osteomeatal unit was scored as 0-no opacification, 2-total opacification. Each side was graded separately and the scores from each side were then added to determine the overall CT Score which ranged from 0 to 24 [3]. CT findings were considered positive for CRS when the Lund-Mackay Score was more than one [3]. Assessment of CT scan and nasal endoscopy in all patients were performed independently by two different assessors and were blinded to each other's scores.

Statistical Analysis

The data from case record forms were tabulated in a Microsoft Excel spreadsheet. Statistical Analysis was done using Statistical Package of Social Science Software program, version 21 (SPSS). Data was tabulated in 2 × 2 contingency tables and statistical tests were applied to calculate sensitivity, specificity, positive predictive value, negative predictive value and accuracy of DNE considering CT scan as a gold standard in diagnosing CRS. The level of agreement between DNE and CT Scan Nose and PNS was determined by calculating kappa statistics.

Results

Total 54 patients of CRS were included in the study. The age of the patients was ranged between 15 and 65 years and maximum patients were of 2nd–3rd decade. Mean age of the study group was 35.48 years (SD ± 16.15). Study comprised of 30 (56%) males and females were 24 (44%)

Table 1 Frequency of paranasal sinus involvement on CT scan in patients of chronic rhinosinusitis (n = 54)

Sinusitis	Unilateral N (%)			Bilateral N (%)	Total N (%)
	Right N (%)	Left N (%)	Total N (%)		
Maxillary	14 (25.93%)	9 (16.67%)	23 (42.59%)	19 (35.19%)	42 (77.78%)
Anterior Ethmoid	9 (16.66%)	6 (11.11%)	15 (27.78%)	22 (40.74%)	37 (68.52%)
Posterior Ethmoid	8 (14.82%)	6 (11.11%)	14 (25.93%)	20 (37.04%)	34 (62.96%)
Frontal	6 (11.11%)	4 (7.40%)	10 (18.52%)	13 (24.07%)	23 (42.93%)
Sphenoid	5 (9.26%)	3 (5.56%)	8 (14.82%)	6 (11.11%)	14 (25.93%)

with male to female ratio of 1.25:1. All the patients had more than one symptom and common symptoms found were nasal discharge in 39 (72.22%) patients, nasal obstruction in 35 (64.81%) patients, headache 33 (61.11%) patients followed by altered sense of smell in 25 (46.29%) and facial pain in 12 (22.22%).

Table 1 shows pattern of sinus involvement on CT scan. Involvement of at least one paranasal sinus was seen in 47 (87.03%) patients. The maxillary sinus was the most commonly affected sinus in 42 (77.78%) patients, followed by anterior ethmoids in 37 (68.52%) patients, posterior ethmoids in 34 (62.96%), frontal in 23 (42.93%) patients and sphenoid in 14 (25.93%) patients.

As shown in Table 2, out of 54 patients, 45 were endoscopy positive. Polyp alone was the commonest observation on nasal endoscopy in 13 (24.07%) patients. Diseased mucosa and polyp was seen in 8 (14.81%), mucopurulent discharge with polyp in 6 (11.11%) and polyp, diseased mucosa with mucopurulent discharge in 7 (12.06) patients.

As shown in Table 3, out of total 54 patients, 45 (83.33%) had abnormal endoscopic findings while 47 (87.03%) patients were showing positive CT scan. Out of 9 patients having normal endoscopy, 3 patients had abnormal CT. But one patient who was CT scan negative was found to be endoscopic positive for CRS and this patient was showing oedematous mucosa at osteomeatal complex on nasal endoscopy. 6 patients were both endoscopy and CT negative for CRS indicating no disease. The sensitivity of endoscopy was 94% (95% CI 81.43–98.33%) and the specificity was 86% (95% CI 42–99.24%). Positive predictive value of DNE was 98% and negative predictive value was 67%. Diagnostic accuracy of DNE in diagnosing CRS was 93%. Most of the endoscopy positive patients of CRS were CT positive. Agreement between DNE and CT scan PNS in diagnosis of CRS was good with kappa coefficient of 0.707.

To study the severity of the disease, Lund-Mackay CT Score and Lund-Kennedy Endoscopy Score were calculated. Mean Lund-Mackay CT Score was 16.37 ± 5.67

Table 2 Frequency of pathology in osteomeatal complex on nasal endoscopy in patients of chronic rhinosinusitis (n = 54)

Pathology detected on nasal endoscopy	No. of patients (N)	Percentage (%)
Polyps	13	24.07
Mucopurulent discharge and polyps	6	11.11
Diseased mucosa and polyps	8	14.81
Polyps, diseased mucosa and mucopurulent discharge	7	12.06
Diseased mucosa	5	9.26
Mucopurulent discharge and diseased mucosa	6	9.26
Total	45	83

Table 3 Correlation between diagnostic nasal endoscopy and CT paranasal sinuses in CRS patients (n = 54)

	CT+	CT–	Total
Endoscopy +	44	1	45
Endoscopy –	3	6	9
Total	47	7	54

Sensitivity— $a/a + c = 44/47 = 94\%$ (95% CI 81.43–98.33%)

Specificity— $d/b + d = 3/4 = 86\%$ (95% CI 42–99.24%)

Positive predictive value— $a/a + b = 44/45 = 98\%$ (95% CI 86.76–99.88%)

Negative predictive value— $d/c + d = 6/9 = 67\%$ (95% CI 30.91–90.95%)

Accuracy = $a + d/a + b + c + d = 50/54 = 93\%$

kappa coefficient—0.707 (good agreement)

and Mean Lund-Kennedy Endoscopy Score was 9.44 ± 3.61 . Correlation between the two scores was calculated by using Pearson's correlation analysis. For Pearson's bivariate correlation coefficient p values ≤ 0.05 was considered as statistical significance. High degree of correlation was found between Lund-Mackay CT Score and Lund-Kennedy Endoscopy Score ($r = 0.881$, p value < 0.0001) (Table 4).

Table 4 Correlation between Lund-Mackay CT Scan Score and Lund-Kennedy Endoscopy Score in patients of chronic rhinosinusitis (n = 54)

Mean CT Score ($\pm$ SD)	Mean Endoscopy Score ($\pm$ SD)	Pearson's bivariate correlation coefficient (r)	p value*
16.37 ($\pm$ 5.67)	9.44 ($\pm$ 3.61)	0.881	<0.0001

*p value < 0.05—statistically significant

Discussion

Rising prevalence of rhinosinusitis is a significant health problem and still poses a challenge for the ENT surgeons in terms of its diagnosis and treatment. We extremely rely upon CT to confirm the diagnosis of CRS, to assess its severity and in management decision. It has become the gold standard in the evaluation and surgical planning for CRS [2]. It has been recently 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 most of objective data used to diagnose CRS [10–12]. Endoscopic findings are often used to support a diagnosis of CRS. But the true diagnostic value of nasal endoscopy in diagnosing CRS has not yet been clearly defined. In this study, we tried to find out the correlation between nasal endoscopy and CT in diagnosis and assessment of severity of CRS.

In the present study, maximum number of patients was in the second and the third decade and the mean age of study group was 35.48 years (SD $\pm$ 16.15). This corresponds with the study carried out by K. Sinha [13] where majority of patients were in the age group of 20–40 and 17–48 years respectively. While Hwang et al. [14] reported mean age of patients as 47.4 years, in their study. Our study showed slight male predominance with male to female ratio of 1.25: 1. In the study conducted by K. Sinha [13], male to female ratio was 1.6:1.

Nayak et al. [15] in his study observed the commonest complaint as nasal discharge occurring in 25 patients (78.1%) followed by headache in 22 patients (68.7%) and nasal obstruction in 22 (68.7%). The other complaints were sneezing in 6 patients (18.7%), anosmia and cacosmia in 2 patients each (6.25%). Our findings are consistent with Nayak et al. [15] study showing nasal discharge (72.22%) as commonest symptom followed by nasal obstruction (64.81%) and Headache (61.11%).

Bhattacharyya et al. [12] and Bradley and Kountakis [16], compared sino-nasal symptoms (Sino-Nasal Outcome Test: SNOT-20) to that with CT scan findings (latter with respect to severity of mucosal thickening) and found no significant agreement between the two.

Rosbe and Jones [17] in 1998, prospectively compared results of nasal endoscopy, CT scanning, and a symptom questionnaire, to determine whether a combination of patient symptoms and nasal endoscopy could accurately predict CRS on CT in 92 consecutive patients referred for sinonasal symptoms. According to them 91% of patients with positive findings on endoscopy had CT scans consistent with CRS. Stankiewicz and Chow [18], in their study of 78 patients of CRS in year 2002, evaluated the relationship between symptoms, nasal endoscopy, and CT findings. The sensitivity of endoscopy as compared with CT was 46%, specificity was 86%, PPV was 74%, and NPV was 64%. Negative endoscopy had a stronger association with CT findings, showing a 78% correlation with CT that was negative or showed minimal sinus disease [18].

The 2010 study by Bhattacharyya and Lee [19] prospectively evaluated 202 patients of CRS. According to them, endoscopy coupled with symptom criteria based on the AAO-HNS guidelines significantly improved the overall accuracy from 42.8 to 69.1%, and the odds ratio from 1.1 to 4.6, as compared with CT results. Endoscopy also increased the PPV from 39.9 to 66.0%, and NPV from 62.5 to 70.3%. There was significant improvement in specificity from 12.3 to 84.1% after the addition of endoscopy [19].

Ferguson et al. [20] evaluated associations between symptom based criteria as well as endoscopy and CT results. The specificity of endoscopy was 100%, sensitivity was only 24%. From this they concluded that High specificity and low sensitivity of endoscopy makes it useful tool for confirming CRS diagnosis but not for ruling it out.

Vining et al. [21] studied the importance of preoperative nasal endoscopy in patients with sinonasal disease and concluded that in patients with positive CT examinations, telescopic nasal endoscopy was especially useful in delineating the type of soft tissue that was blocking the area of the middle meatus. In patients with CT examinations negative, telescopic examination demonstrated septal deflections, mucosal oedema involving the middle meatus, as well as turbinate and adenoid hypertrophy. A study done by Buljick-Cupic et al. [22] on endonasal endoscopy and computerized tomography to detect middle meatus pathology, the correlation between computerized tomography and nasal endoscopy of sixty nasal cavities of examined patients was significantly high with mean kappa coefficient of $\kappa = 0.89$, $\kappa > 0.8$. He concluded that endonasal endoscopy is the method of choice to make a specific diagnosis and provide specific treatment [22]. Our findings are consistent with this study showing kappa coefficient of 0.707 indicating good agreement between Nasal endoscopy and CT scan in diagnosis of CRS.

In the studies done by Deepthi et al. [23] in 2013 and Pokharel et al. [24] in 2013, there was high degree of

correlation between preoperative Endoscopy Score and CT Score with Pearson's correlation coefficient of 0.94 and 0.556 respectively. In our study Pearson's correlation coefficient was 0.881 indicating high degree of correlation between Lund-Mackay CT Score and Lund-Kennedy Endoscopy Score.

Most of the previous studies were based on symptom based diagnostic criteria and investigated its diagnostic accuracy based on CT scan or endoscopy or both. This study was conducted to evaluate the diagnostic accuracy of nasal endoscopy and to know whether it can be used as an alternative diagnostic test to CT scan which is the gold standard.

Conclusion

Endoscopy is valuable diagnostic test in individuals presenting with symptoms of CRS. It can be used as a good predictor of sinus disease to confirm the diagnosis and to know the severity of the disease. This can help the initiation of medical management of CRS. CT scan should be reserved to those with negative endoscopy but having high clinical suspicion and in those who are not responding to medical management and need surgical intervention. This will reduce monetary burden over patient and prevent unnecessary radiation exposure.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Approval The permission was taken from Institutional Ethics Committee prior to starting the project. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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