Indian J Otolaryngol Head Neck Surg
(Apr–June 2016) 68(2):224–229; DOI 10.1007/s12070-015-0907-7

ORIGINAL ARTICLE

Comparative Study of Diagnostic Nasal Endoscopy and CT Paranasal Sinuses in Diagnosing Chronic Rhinosinusitis

Sweta S. Lohiya[1] · Seema V. Patel[1] · Apurva M. Pawde[1] · Bhagyashree D. Bokare[1] · Prafulla T. Sakhare[1]

Received: 2 July 2015 / Accepted: 16 September 2015 / Published online: 23 September 2015

Abstract Evaluation of the accuracy of objective diagnostic modalities for chronic rhinosinusitis and their comparison to each other to reach the correct diagnosis with minimum cost and highest accuracy. Prospective diagnostic cohort study. Academic medical center. Subjects more than 10 years of age presenting for evaluation of chronic rhinosinusitis, not responding to 12 weeks of medical treatment, suffering from at least 2 or more of the following symptoms- nasal obstruction, anterior and or posterior nasal discharge, headache or facial pains, and abnormalities of smell were prospectively studied. All selected patients were subjected to nasal endoscopy and CT paranasal sinuses. Endoscopic findings were scored according to Lund Kennedy scoring system. Sinus CT scans were scored with the Lund Mackay scoring system. The clinical diagnosis of CRS was determined on the basis of the published adult sinusitis guideline criteria and nasal endoscopic findings were compared with the diagnostic gold standard CT. A total of 100 patients were studied. Endoscopy was able to diagnose 87 % as CRS based on Lund–Kennedy score ≥2. 93 % patients could be labeled as CRS based on Lund–Mackey score ≥4. On correlating endoscopy and CT PNS it was found that sensitivity was 88.04 %, specificity was 28.57 %, PPV was 94.19 %, NPV was 15.38 %. Positive likelihood ratio of 1.23 and negative likelihood ratio of 0.42 was found *p* value was found to be 0.10565, thereby confirming that there is no significant difference in diagnosing CRS by either modality. The addition of nasal endoscopy helps reduce the use of CT, reducing costs and radiation exposure

Keywords Chronic rhinosinusitis (CRS) · Diagnostic nasal endoscopy (DNE) · Computed tomography of paranal sinuses (CT PNS)

Introduction

A study by the National Institute of Allergy and Infectious Diseases (NIAID) recently conclude that 134 million Indians suffer from chronic rhinosinusitis, which is more than double the number of diabetic patients in India, having great personal and economic impact. Beside the enormous economic burden of CRS, there is also significant patient morbidity in terms of quality of life and decreased overall productivity caused by CRS as measured by various studies [6, 7].

Rhinosinusitis is a broad diagnostic term that encompass a spectrum of disorders involving concurrent inflammation of the mucosa of the nose and paranasal sinuses [1, 2]. Past attempts at defining rhinosinusitis have been purely symptom based. Approximately 87 % of visits for the diagnosis and management of rhinosinusitis are in the primary care setting where nasal endoscopy and computed tomography (CT) imaging are not routinely used for diagnosis. Consequently, a variety of national and international consensus meetings have developed symptom-based definitions for the initial diagnosis of rhinosinusitis [3–5].

For reaching towards a proper diagnosis and management of CRS, in 2007, new guidelines for rhinosinusitis, from a multidisciplinary panel commissioned by American Academy of Otolaryngology-Head and Neck surgery, were

✉ Seema V. Patel
drpatelseema@gmail.com

[1] Department of ENT and Head and Neck Surgery, Government Medical College, Nagpur, Maharashtra, India

published. The 12 major and minor symptoms of CRS were narrowed to four specific symptoms, and documentation of middle meatal inflammation was added to the diagnostic criteria for CRS in the hopes that objective data would improve diagnostic accuracy [3, 7].

Twelve weeks or longer of two or more of the following signs and symptoms:

- mucopurulent drainage (anterior, posterior, or both);
- nasal obstruction (congestion);
- facial pain-pressure-fullness; or
- decreased sense of smell.

Furthermore, an *objective* measure was required for the diagnosis of CRS: Inflammation documented by one or more of the following findings:

- purulent (not clear) mucus or edema in the middle meatus or ethmoid region;
- polyps in nasal cavity or the middle meatus; and/or
- radiographic imaging demonstrating inflammation of the paranasal sinuses.

So this study was designed to evaluate the accuracy of objective diagnostic modality, namely nasal endoscopy and to compare it with gold standard diagnostic modality namely sinus CT scan.

Methods

We performed a prospective diagnostic cohort study in the department of otorhinolaryngology, Government Medical College, Nagpur, with the approval of ethical committee. Over a period of 2 years 100 adult patients attending ENT outpatient department, who were clinically diagnosed as CRS on the basis of detailed history and clinical examination and not responding to 12 weeks of medical treatment and suffering from at least 2 of the following symptoms (According to criterias described by AAO-HNS 2007) [7], Nasal obstruction, Anterior and/or posterior nasal discharge, Headache/facial pains and/or Abnormalities of smell were included in the study. Subjects less than 10 years of age, those with history of previous sinonasal surgery, sinonasal malignancy, Cystic fibrosis, autoimmune disease, suffering from immunocompromised disorders, and Patients who declined to participate were excluded from the study. Subjects were evaluated by using the presence of two or more symptoms, nasal endoscopy, and paranasal sinus computed tomography (CT).

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 in the office with a 0 degree and 30-degree rigid endoscope. First, the endoscope was passed without decongestion or anaesthesia to look for the status of mucosa. Thereafter under topical anaesthesia, DNE was performed with a Zero degree and/or Thirty degree rigid endoscopes. Presence or absence of (1) mucosal edema (2) watery or purulent discharge and (3) polyps was recorded. The findings were then quantified using the *Lund–Kennedy* scoring system [10]. The diagnostic evidence of CRS was defined by a Lund Kennedy endoscopic score $\geq$2. Also the anatomical variations present were noted. The endoscopist was blinded to patients symptoms. Each patient was then prepared for CT scan. During DNE all the secretions were suctioned, decongestion was done, and then patient was sent for sinus CT. CT scan was performed with Phillips ICT BRILLIANCE 256 slice, 1 mm cuts, within 7 days of nasal endoscopy. Plain CT scan paranasal sinuses, axial and coronal cuts with saggital reconstruction was done. All anatomical variations were noted. Each patient *CT scan of paranasal sinuses* was then staged using *Lund Mackay* CT scoring system [8, 9]. The reviewer was blinded to endoscopic findings. The diagnostic evidence of CRS was defined by a Lund Mackay score greater than or equal to 4. Data for anatomical variations, endoscopic findings and CT scores were tabulated in Excel (Microsoft, Redmond, WA) 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 14–65 years, mean age 35.6 years, standard deviation [SD] 14.4, 52 % male). 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 95, 66, 60 and 54 %, respectively.

Among those patients with positive nasal endoscopy findings edematous mucosa was seen in 39 % subjects, mild edema in 10 % and severe edema in 29 % subjects. Discharge was seen in middle meatus in 47 %, on right side discharge was seen in 11 %, on the left side discharge was seen in 22 %, bilateral discharge was seen in 14 %. 16 % subjects had clear and thin discharge while 31 % had purulent discharge. 4 % polyps were seen on right, 6 % on left and bilateral in 17 %, with a total of 27 % subjects having polyps. 5 % subjects had polyp confined to middle meatus, and 22 % had polyp beyond middle meatus. According to Lund–Kennedy scoring system 13 % subjects

had score <2, 51 % had scores between 2 and 4, 27 % had scores between 5 and 8, and only 9 % subjects had score between 9 and 12. The mean score was 4.2 and range 0–12.

Various anatomical variations seen on nasal endoscopy were septal deviation 79 %, agger nasi 35 %, paradoxical middle turbinate 28 %, concha bullosa 28 %, accessory maxillary ostium 21 %, uncinate process hypertrophy 16 % and enlarged bulla ethmoidalis 4 %.

On studying the CT scans we found that 79 % had septal deviation and/or spur, 33 % right, 33 % left, 13 % s shaped/deviation on one side and spur on the other side; 27 % have polyp, 4 % right, 6 % left, 17 % bilateral; 21 % accessory maxillary ostium, 7 % right, 10 % left, 4 % bilateral; 41 % Agger nasi, 16 % right, 10 % left, 15 % bilateral; 32 % concha bullosa, 12 % right, 10 % left, 10 % bilateral; 30 % paradoxical middle turbinate, 13 % right, 8 % left, 9 % bilateral; 16 % pneumatised uncinate process, 4 % right, 6 % left, 6 % bilateral; 8 % overneumatised ethmoid bulla, 3 % right, 3 % left, 2 % bilateral; 7 % Haller cells, 2 % right, 3 % left, 2 % bilateral;3 % Onodi cells, 3 % right, 3 % left, 3 % bilateral.

We found that 60.5 % patient had osteomeatal complex opacification, 62.25 % maxillary sinus haziness, 54.5 % anterior ethmoid sinus haziness, 32.25 % posterior ethmoid sinus haziness, 24.5 % frontal sinus haziness and 19.75 % sphenoid sinus haziness.

On scoring according to lund mackay scoring of CT PNS, 20 % subjects had scores between 0 and 4, of which 7 % had scores less than 4, 29 % had scores between 5 and 8, 20 % had scores between 9 and 12, 17 % subjects had score between 13 and 16, and only 7 % each had scores between 17–20 and 20–24. The mean score was 9.8 and range 0–24.

On comparing CT and endoscopy, septal deviation/spur was found in 79 %, polyps in 27 % and accessory maxillary ostium 21 % each on endoscopy and CT, Agger nasi 35 % on endoscopy, 41 % on CT; paradoxical middle turbinate 28 % on endoscopy and 30 % on CT, Concha bullosa 28 % on endoscopy and 32 % on CT, large bulla ethmoidalis 4 % on endoscopy and 8 % on CT.

87 % Patients had Lund–Kennedy score >2 and 13 %, <2. 87 % patients were diagnosed as CRS on endoscopy and 13 % not diagnosed on endoscopy.

93 % Patients had Lund–Mackay score >4 and 7 % <4. 93 % patients were diagnosed as CRS on CT scan and 7 % not diagnosed on CT scan.

87 % Patients were diagnosed on endoscopy and 93 % patients were diagnosed on CT scan. 13 and 7 % patients each were not diagnosed on endoscopy and on CT scan respectively.

Considering CT scan as gold standard, accuracy of nasal endoscopy was calculated. The sensitivity of nasal endoscopy is 88.04 %, that is, the probability of diagnosing CRS when it is present is 88.04 %, but specificity is low 28.57 % that is it is unable to exclude the disease.

Positive predictive value is 94.19 %, meaning thereby that 94.19 % patients have probability that the disease is present when the test is positive.

Negative predictive value is 15.38 %, meaning thereby that 15.38 % patients have the probability that the disease is not present when the test is negative.

Positive likelihood ratio is 1.23 and negative likelihood ratio is 0.42, therefore indicating that there is a high correlation between CT scan and endoscopic findings.

The p value was 0.10565, which is insignificant, indicating there is no significant difference in diagnosing CRS by endoscopy or CT scan.

Discussion

The diagnostic utility of nasal endoscopy, in relation to common clinical and radiologic criteria, has been assessed in relatively few clinical studies. In 1997 a study by Benninger [13] evaluated the role of nasal endoscopy in the diagnosis and treatment planning in 100 consecutive patients with sinonasal complaints. In this study all diagnosis were made based on history and physical examination that included anterior rhinoscopy. Out of 100 patients only 28 were diagnosed as CRS. The role of endoscopy in this study was to determine if the endoscopic findings contradict the established diagnosis. The study did not compare the results of endoscopy with CT scans. Although the addition of endoscopy did not change any of the diagnosis of CRS, the study concluded that it was useful in evaluating patients in whom anterior rhinoscopy is limited either by anatomic abnormalities or in whom the diagnosis is otherwise unclear.

A 1998 study by Rosbe et al. [14] prospectively compared results of nasal endoscopy, CT scanning, and a symptom questionnaire, with a goal of determining whether a combination of patient symptoms and nasal endoscopy could accurately predict CRS on CT in 92 consecutive patients referred for sinonasal symptoms. The study obtained CT scans on all patients with endoscopic findings positive or equivocal for CRS. They found that 91 % of patients with positive findings on endoscopy had CT scans consistent with CRS. Of the patients with a chief complaint of nasal obstruction who had a positive finding on 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, nasal endoscopy can be

Table 1 Role of diagnostic nasal endoscopy and ct paranasal sinuses in diagnosing chronic rhinosinusitis

Study	Year	Statistical measure	No.	Conclusions
Benninger et al. [13]	1997	Proportion (11 %)*	100	Endoscopy useful only when diagnosis unclear
Rosbe et al. [14]	1998	Proportion (91 %)**	92	High specificity of endoscopy
Stankiewicz et al. [11]	2002	Sensitivity (46 %), specificity (86 %), PPV (74 %), NPV (64 %)	78	Low correlation with subjective symptoms, high specificity of endoscopy
Bhattacharyya et al. [12]	2010	PPV (66.0), NPV (70.3), OR (4.6)	202	Addition of endoscopy to subjective symptoms greatly improved the diagnostic accuracy
Ferguson et al. [15]	2012	Sensitivity (24 %), specificity (100 %)	125	High specificity and low sensitivity of endoscopy make it useful for confirming CRS diagnosis but not for ruling it out
Present study	2014	Sensitivity (88.04 %), sensitivity (28.57 %), PPV (94.19 %), NPV (15.38 %), PLR (1.23), NLR (0.42), *p* value (0.10565)	100	High sensitivity and PPV makes endoscopy a diagnostic modality to accurately diagnose the disease but does not rule it out

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

* Proportion in Benninger et al. [13] study means proportion of participants in whom nasal endoscopy played an important role in the evaluation when added to history and physical examination with anterior rhinoscopy

** Proportion in Rosbe et al. [14] study indicates proportion of participants with positive endoscopy findings who also had computed tomography positive for CRS

a highly specific technique for predicting positive CT findings of CRS.

In a 2002 study of 78 patients meeting the current symptom-based definition of CRS, Stankiewicz and Chow [11] evaluated the relationship between symptom history, nasal endoscopy, and CT findings. Nasal endoscopy was considered positive for CRS if it demonstrated purulence, nasal polyps, or watery congested mucosa. Of the 37 patients with positive CT findings, 17 had positive endoscopic results, and 20 had negative endoscopic results. The sensitivity of endoscopy as compared with CT results 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. Although the study did not compare the combination of history and endoscopy with CT results, it did note the low correlation between subjective symptom-based criteria for CRS and findings on CT and endoscopy, as well as a high specificity of endoscopy as compared with CT results.

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

Bhattacharyya et al. [12] 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 polyps with CT findings. They found that the addition of endoscopy to 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 %. The most dramatic improvement was in specificity, which increased from 12.3 to 84.1 % after the addition of endoscopy. The study determined that, in patients who met symptom criteria for CRS, the addition of nasal endoscopy significantly improved diagnostic accuracy for CRS. It concluded that in select patients, endoscopy may help reduce CT utilization in making the diagnosis of CRS.

Study done by Ferguson et al. [15], evaluated associations between symptom based criteria as well as specific findings of mucopurulence and CT results. The study found that the overall accuracy of subjective symptoms for predicting CRS on CT was low. However, the endoscopic finding of mucopurulence was only present in patients with positive CRS on CT, and never seen in those with negative CT results. The study did not analyze the PPV or NPV of endoscopy compared with CT, the specificity of endoscopy was 100 %. The sensitivity was only 24 %. The conclusion of the study was that endoscopy can confirm a CRS diagnosis, but cannot rule it out, and that CT should be performed in cases of suspected CRS even if mucopurulence is not noted on endoscopy (Table 1).

In our study endoscopy when compared to gold standard CT scan, we found sensitivity 88.04 %, specificity 28.57 %, positive predictive value 94.19 %, negative predictive value 15.38 %, positive likelihood ratio 1.23,

negative likelihood ratio 0.42, thereby showing that nasal endoscopy had high sensitivity for diagnosing the disease but not specific enough to refute the diagnosis

High positive likelihood ratio of 1.23 and low negative likelihood ratio of 0.42 was found thereby showing that endoscopic and CT PNS findings are consistent with each other in diagnosing most of the cases

In study conducted by Bhattacharya et al. conducted in 2010, [12] considering 2007 criteria for diagnosis. The symptoms were graded according to six point Likert-scale as mild and moderate symptoms and then added advantage of endoscopy was determined. In our study we had only considered presence of 2 or more symptoms according to 2007 criteria. While doing endoscopy they only considered the presence of polyp or purulent discharge. They did not consider edema as it was thought to be subjective, whereas we had used Lund–Kennedy scoring system for diagnosing patients for CRS. Both Bhattacharya et al. and our study used Lund–Mackay system for diagnosis of CRS on CT scan. Bhattacharya et al. found the addition of endoscopy to 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 %. The most dramatic improvement was in specificity, which increased from 12.3 to 84.1 % after the addition of endoscopy. Whereas in our study we did not have controls, edema of mucosa was considered a positive finding and on comparison we found that 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, respectively, thereby showing that nasal endoscopy had high sensitivity for diagnosing the disease.

Conclusion

In conclusion, we find that in patients who meet guideline symptom criteria for CRS, the addition of nasal endoscopy improves diagnostic accuracy for CRS and should be emphasized as a early diagnostic tool in the clinical evaluation. It should be considered as an office based procedure and performed on all patients suspected of having CRS. Diagnostic nasal endoscopy helps reduce CT utilization, thereby reducing cost and radiation exposure in a large segment of the population being evaluated for CRS. Diagnostic endoscopy, a less expensive, easily accessible tool, offers an advantage in the diagnosis of CRS. In patients with limited or poor endoscopic visualization, due to polyps, or septal deviation or crowding of osteomeatal complex and presence of hidden air spaces like sphenoid sinus, ethmoid bulla and posterior ethmoids, CT scan is useful in discerning the disease.

In light of these findings, we propose that if a patient meets guideline symptom criteria and has positive endoscopic findings on examination, it would be reasonable to treat with a clinically presumed diagnosis of CRS before obtaining a paranasal sinus CT scan. Sinus imaging could then be considered for those patients with refractory symptoms despite maximal therapy and in those cases where surgery is being planned.

Compliance with Ethical Standards

Conflict of interest Sweta S. Lohiya, Seema V. Patel, Apurva M. Pawde, Bhagyashree D. Bokare, Prafulla T. Sakhare declare that they have no conflict of interest.

Ethical Approval 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.

References

1. Fokkens W, Lund V, Mullol J (2007) European position paper on rhinosinusitis and nasal polyps. Rhinology 2007:1–136
2. Benninger MS, Ferguson BJ, Hadley JA et al (2003) Adult chronic rhinosinusitis: definitions, diagnosis, epidemiology, and pathophysiology. Otolaryngol Head Neck Surg 129:S1–S32
3. Lanza DC, Kennedy DW (1997) Adult rhinosinusitis defined. Otolaryngol Head Neck Surg 117:S1–S7
4. Kaliner MA, Osguthorpe JD, Fireman P et al (1997) Sinusitis: bench to bedside. Current findings, future directions. Otolaryngol Head Neck Surg 116:S1–S20
5. Fokkens W, Lund V, Bachert C et al (2005) EAACI position paper on rhinosinusitis and nasal polyps executive summary. Allergy 60:583–601
6. Tahamiler R, Canakcioglu S, Ogreden S et al (2007) The accuracy of symptom-based definition of chronic rhinosinusitis. Allergy 62:1029–1032
7. Rosenfeld Richard M, Andes D, Bhattacharyya N, Cheung D, Eisenberg S et al (2007) Clinical practice guideline. Otolaryngol Head Neck Surg 137(Suppl):S1–S31
8. Hopkins Claire (2007) The Lund–Mackay staging system for chronic rhinosinusitis: How is it used and what does it predict? Otolaryngol Head Neck Surg 137:555–561
9. Lund V, Mackay IS (1993) Staging in chronic rhinosinusitis. Rhinology 31:183–184
10. Lund VJ, Kennedy DW (1995) Quantification for staging sinusitis. The Staging and Therapy Group. Ann Otol Rhinol Laryngol Suppl 167:17–21
11. Stankiewicz JA, Chow JM (2002) Nasal endoscopy and the definition and diagnosis of chronic rhinosinusitis. Otolaryngol Head Neck Surg 126:623–627
12. Bhattacharyya N, Lee LN (2010) Evaluating the diagnosis of chronic rhinosinusitis based on clinical guidelines and endoscopy. Otolaryngol Head Neck Surg 143:147–151

13. Benninger MS (1997) Nasal endoscopy: its role in office diagnosis. Am J Rhinol 11:177–180
14. Rosbe KW, Jones KR (1998) Usefulness of patient symptoms and nasal endoscopy in the diagnosis of chronic sinusitis. Am J Rhinol 12:167–171
15. Ferguson BJ, Narita M, Yu VL, Wagener MM, Gwaltney JM Jr (2012) Prospective observational study of chronic rhinosinusitis: environmental triggers and antibiotic implications. Clin Infect Dis 54:62–68