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Association Between Clinical Symptoms and CT Findings in Chronic Rhinosinusitis

Background/Objective: This study was conducted to find out the association between the clinical symptoms of chronic rhinosinusitis (CRS) and CT findings.

Patients and Methods: 50 patients with CRS were studied. Their clinical symptoms were recorded according to the sinonasal outcome questionnaire (SNOT-20) and their CT findings were graded by the Lund-Mackay grading system. The Pearson correlation coefficient was assessed between these two scores. Also we used multiple regression models for adjusted association among variables.

Results: The mean±SD of SNOT-20 and the Lund-Mackay score were 45±8.7 (range: 29-67) and 18.5±5 (range: 8-24), respectively. The mean±SD SNOT-20 score was higher for post-nasal drip (PND) and facial pain; the lowest mean scores were for dizziness and ear pain. Pearson's correlation coefficient of SNOT-20 and the Lund-Mackay grading system was 0.74 (p=0.0001). In simple regression analysis considering the Lund-Mackay score as dependent variable and SNOT symptom domains (nasal, oropharyngeal, sleep, facial, and systemic) as independent variables, the best associated clinical symptom domain was the nasal symptom domain (model r^2=0.76; p<0.0001). In the multivariate linear regression model, considering the five symptom domains as independent variables, the model r^2 was 0.8 (p<0.0001) and the only significant variable in the model was the nasal symptom domain (p<0.0001).

Conclusion: Patients with higher symptom scores are more likely to have CT imaging evidence of rhinosinusitis.

Keywords: Chronic Rhinosinusitis, Computed Tomography, Sinusitis Symptom Scores

Introduction

Chronic rhinosinusitis (CRS) is one of the most common chronic diseases that poses a great challenge to specialists in the field of rhino-otolaryngology.

The primary diagnosis of CRS is based on history and physical examination.

Indeed, CT of the paranasal sinuses is indicated for patients who failed to respond to medical treatment before surgical procedures.[1,2]

For the better understanding of these conditions, many investigators have attempted to define this disease based on CT scores and findings.

Several CT staging systems have been proposed for the evaluation of CRS.

The American academy of otolaryngology has recommended the Lund-Mackay system as the preferred method for staging of CRS.[3]

Attempts for better clinical definition and evaluation of rhinosinusitis have included methods for evaluation of patient symptoms such as the minor symptom criteria, the 20-item sinonasal outcome test (SNOT-20), and the chronic sinusitis survey (CSS).[4-6]

SNOT-20 is the most commonly used validated health instrument according to many specialists.[7] Some studies suggested that preoperative symptoms do not have good correlation with the CT scan stage.[8-10] However, some studies suggest that the preoperative CT scan stage may predict symptom improvement

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after ESS.[6]

In this study, we evaluated the pre-operative symptom scores and CT of patients with CRS. Our purpose was to find out whether any correlation exists between the degree and severity of symptoms assessed by the SNOT-20 questionnaire and the CT findings graded by the Lund-Mackay grading system in CRS.

Patients and Methods

Fifty patients with the diagnosis of CRS from the department of otolaryngology were prospectively included in this study.

Our referral university affiliated hospital's ethics committee on clinical investigations approved this study. Informed written consent was obtained from all patients.

CRS was diagnosed if the patient reported two or more of the following symptoms for more than one hour on most days for two months or more: 1) anosmia/hyposmia; 2) nasal blockage/congestion; 3) poste rior rhinorrhea and 4) headache/facial pain.[11]

All patients had their CT graded according to the Lund-Mackay grading system.[12]

CTs were performed on a Shimadzu system (Model 7800, Japan) in the coronal plane at 120 kV and 150 mA with 5-mm intervals with gantry tilt, and a 2-sec scan time.

The slice thickness of the images was 3 mm for osteomeatal complexes, and 5 mm for other sites. The window width and window level of our images were 2000 and 500, respectively.

The patients were evaluated with the SNOT-20.[4]

The two radiologists were blinded for the patient's symptoms and SNOT-20 scores and so were the two specialists who evaluated the SNOT-20.

We categorized the SNOT-20 items into five domains and evaluated the total score and also the association between each domain and the Lund-Mackay scores.

These domains included "nasal symptom domain" (need to blow nose, sneezing, runny nose, thick nasal discharge; maximum score of 20); "oropharyngeal symptom domain" (cough, post-nasal drip [PND], ear fullness, dizziness, ear pain; maximum score of 25); "facial symptom domain" (facial pain); "sleep related symptom domain" (difficulty falling asleep, waking up at night, lack of good night's sleep, waking up tired; maximum score of 20); and "systemic symptom domain" (fatigue, reduced productivity, reduced concentration, frustration, sadness, embarrassment; maximum score of 30).

All results were analyzed by SPSS® ver 11.5 for Windows®. Pearson correlation coefficient was computed to determine whether the CT stage according to the Lund-Mackay scoring system associated with the SNOT-20 scores.

In the Lund-Mackay system, each side of the paranasal sinuses (right and left) is scored separately. The ethmoid sinus is divided into anterior and posterior. Score 0 shows no abnormality; score 1 designates partial opacification and score 2 indicates total opacification. Osteomeatal complexes are scored as either 0 (not obstructed) or 2 (obstructed). The total score can range from 0 to 24.

Pearson correlation coefficient was computed to determine the linear correlations. Also, we used simple and multiple linear regression models for the evaluation of adjusted association among CT scoring as a dependent variable and SNOT-20 score and it's domains as independent variables. P values <0.05 were considered statistically significant.

Results

The study consisted of 50 diagnosed CRS patients referred to the department of otolaryngology.

The mean±SD age of our patients was 32.4±8.5 years. Thirty-two (64%) patients were male and 18 (36%) were female.

The mean±SD SNOT-20 score was 45±8.7 (range: 29–67) and the mean±SD Lund-Mackay sinus score was 18.5±5 (range: 8–24). The mean±SD for each SNOT-20 item is shown in Table 1.

PND and facial pain had the highest mean±SD SNOT-20 score and the lowest mean scores were for dizziness and ear pain.

The mean±SD score for each domain is shown in Table 2.

The maximum nasal domain scores in our patients were in the average of 11-15 (46% of patients). The maximum scores for the oropharyngeal, sleep and systemic domains were in the average of 6-10 (56% of patients), 11-15 (56% of patients), and 11-15 (66% of

Table 1. Mean±SD of SNOT-20 Scores in Different Symptoms

Symptom	Mean Score ± SD
Need to blow nose	3.1±1.4
Sneezing	3±1
Runny nose	3.2±1.2
Cough	2.5±1.3
PND	4±1.1
Thick nasal discharge	3.7±1
Ear fullness	1.4±0.6
Dizziness	0.9±1
Ear pain	0.9±1.2
Facial pain	3.9±1.3
Difficulty falling asleep	1.6±1
Wake-up at night	1±0.7
Lack of good night sleep	1.3±0.8
Wake-up tired	1.8±1.4
Fatigue	3±1.2
Reduced productivity	3.1±1.5
Reduced concentration	1.5±0.7
Frustration	1.6±0.9
Sad	2.2±1.1
Embarrassement	1.3±1.2

patients), respectively.

There was a good correlation between SNOT-20 scores and CT scores (Pearson's r=0.74, P=0.0001). The correlation coefficients between the Lund-Mackay score and each domain (nasal, oropharyngeal, facial, sleep, and systemic) are shown in Table 3.

For better assessment of association of the disease severity on CT scan findings according to the Lund-Mackay scoring, we used regression models. At first, we entered each domain in a simple linear regression model (that yielded five different models). Then, we entered the SNOT-20 in another simple model. Finally, we entered all five models in a multiple linear regression model. In all models, the Lund-Mackay score was the dependent variable.

Reviewing simple models reveals the best models go for nasal and SNOT models (r^2=0.76 and 0.59, respectively) and the other models are weak for predicting Lund-Mackay scores according to the clinical symptom scores (symptoms related to oropharyngeal, sleep, systemic and facial complaints) (Table 4).

It means that the strongest association of CT findings was that related to nasal complaints, and that other symptoms did not reflect well in imaging. In addition, in the multivariable model, r^2 was the highest (greater than all simple models) and the only statistically significant variable in the model was nasal complaints (P<0.0001); other variables had no statistically significant coefficient in the model (all P values >0.05) (Table 5).

Discussion

CRS is a great problem resulting in patient morbidity and large expenditures on health care.

The diagnosis of rhinosinusitis is based on physical examination and the patients' symptoms. Some physicians use sinus CT in the evaluation and management of this disease.

Our study was conducted to evaluate the association between the patients' symptoms according to SNOT-20 and their CT findings based on the Lund-Mackay score. The SNOT-20 is a subjective and the Lund-Mackay score is an objective score, so the combination of them could provide a suitable way to help physicians understand the severity of the disease.

Previous studies on this subject have failed to arrive at uniform conclusions.

Flinn et al., reported that paranasal sinus abnormalities on CT are common. This study reported that 22% of the patients with no symptoms of rhinosinusitis had sinus opacification.[13]

Bolger et al, found that mucosal abnormalities occurred in 153 (92.2%) of 166 patients scanned for chronic sinus complaints and in 15 (41.7%) of 36 patients scanned for reasons other than sinus involvement.[14]

Table 2. The Mean±SD Score of Each Domain

Domains	Minimum (%)	Maximum (%)	Mean±SD (%)
Nasal	7(35)	19(95)	13±3.3(65±17)
Oropharyngeal	4(16)	16(64)	9.6±2.9(38±12)
Facial	1(20)	5(100)	3.9±1.3(77±27)
Sleep	1(5)	10(50)	5.8±2.1(29±11)
Systemic	7(23)	20(67)	12.7±2.5(42±9)

Table 3. Pearson Correlation Coefficient of the Lund-Mackay Score with Symptom Domains

Domains	r	P-value
Nasal	0.85	<0.0001
Oropharyngeal	0.56	<0.0001
Facial	0.47	<0.001
Sleep	0.2	0.14
Systemic	0.36	0.011

Table 4. Simple Linear Regression Models of Lund-Mackay with Clinical Symptoms

All five domains (univariate)	Model r^2	Coefficient	95% CI for coefficient	P value	Constant	P value
Nasal	0.76	1.29	1.1–1.5	<0.0001	1.73	0.2
Oropharyngeal	0.34	1	0.61–1.4	<0.0001	8.7	<0.0001
Sleep	0.05	0.51	-0.15–1.17	0.13	15.5	<0.0001
Facial	0.22	1.75	0.8–2.7	0.001	11.7	<0.0001
Systemic	0.15	0.74	0.2–1.26	0.006	9.1	0.009
SNOT-20	0.59	0.44	0.33–0.55	<0.0001	-1.28	0.6

Shields et al., concluded that there was no correlation between the severity of facial pain and the disease severity by sinus CT.[15]

In 2005, Bradley and Kauntakis reported that the severity of rhinosinusitis on preoperative CT does not predict the severity of symptoms as assessed by the SNOT-20 inventory in patients who were candidates for functional endoscopic sinus surgery.[7]

Basu et al., also assessed the correlation between preoperative symptom scores using the sinonasal assessment questionnaire (SNAQ) and CT scores (Lund-Mackay) in patients undergoing endoscopic sinus surgery and finally found no statistically significant correlation between these scores.[16]

Kenny et al., designed a study to determine the correlation between the severity of CT evidence for rhinosinusitis and the severity of the patients' report of fatigue, sleep disturbances or postnasal drip (PND), nasal blockage, and decreased sense of smell. They found no correlation between CT findings of rhinosinusitis and the severity of the above symptoms. In addition, no correlation was detected between CT of rhinosinusitis and headache, facial pain or pressure. They found that the correlation of CT scoring according to the Lund-Mackay system with nasal discharge, PND, blocked nose, decreased sense of smell and lack of good night's sleep were significant.[9]

Bhattacharyya et al., reported their findings of 221 patients referred for the assessment of CRS.[8] They compared SNOT-20 and CT based on the severity of mucosal thickening. The authors found no significant correlation between the severity of score measures in the CT and SNOT-20. In their study, patients with significant facial pain symptoms had lower mean CT scores.[8]

Table 5. Multivariable Regression Models of Lund-Mackay with Clinical Symptoms

All five domains (multivariate)	Model coefficient	95% CI for coefficient	P value
Nasal	1.1	0.37–1.5	<0.0001
Oropharyngeal	0.32	-0.07–0.7	0.1
Sleep	-0.34	-0.7–0.004	0.53
Facial	0.71	-0.05–1.5	0.065
Systemic	-0.06	-0.39–0.26	0.7

r^2 =0.80, (P value < 0.001), model constant = 1.23, (P value = 0.5)

Stewart and colleagues reported the correlations between symptom scores and CT findings of 254 patients.[17] They conducted their study using two CT staging systems (Lund-Mackay and Harvard system) and two symptom severity measures (the chronic sinusitis survey and the sinonasal outcome test-20). They also found no correlation between CT and symptom scores.[17]

In our study, in contrast to many other studies, we found a good association between the overall severity of the patients' symptoms and CT findings (r = 0.74, simple model r^2=0.59 for SNOT and multivariable model r^2 for five symptom domains=0.8; all P values<0.05).

One possible cause of the different results in the literature, concerning symptom associations with CT findings, is that different investigators have used heterogeneous populations for their studies. Some investigators have studied symptom correlations in patients referred for the evaluation of CRS (all-comers) and other researchers have evaluated only those who were considered for surgery.

The second possible reason for the differences may be due to different methods of assessing symptoms in these patients (SNOT-20 *vs* CSS or SNAQ).

In addition, the different methods of evaluating and scoring CT (Lund-Mackay *vs* Harvard system) may be involved. Another factor could be the different number of patients studied.

Reviewing the simple and multivariable regression models reveals that "nasal complaints" is the only

clinical symptom domain that has a good correlation with CT findings, while considering oropharyngeal and facial symptoms, we have a moderate correlation and for sleep and systemic symptoms, we have no correlation with CT.

One possible explanation for these results is that sleep and systemic symptoms are nonspecific complaints that may be due to causes other than sinonasal pathologic changes. For example, patients with a history of allergy that could have a CRS simultaneously may have some degree of sleep disturbance independent of the CRS pathologic changes.

In contrast, nasal and oropharyngeal symptoms are more specific complaints that are directly accompanied by persistent mucosal changes visible on CT. Besides, sleep and systemic symptoms are complaints seen in both patients with a history of rhinosinusitis, and those without any demonstrable history of rhinosinusitis.

On the other hand, as sleep related and systemic symptoms are nonspecific complaints of patients with rhinosinusitis; they are poor predictors of the disease severity on CT of the sinuses.

According to the results that indicate poor association between the severity of some clinical symptoms and CT findings, we could say that evaluation of some of these findings such as sleep disturbances in the SNOT-20, need some revisions. Further studies are recommended for better scoring of the patients' symptoms.

Another possible explanation for this discrepancy between the association of symptom domains and CT findings could be due to the fact that there are some pathophysiologic aspects of the disease that are not correlated with the anatomical changes; in fact, these pathophysiological events are not reflected in CT imaging as anatomical changes. For example, the type of the microbial flora of the involved sinuses could be important in the clinical symptoms they cause but may not show any difference in CT imaging. In addition, evaluation of the contribution of each involved sinuse could be an interesting research subject, as each sinus involvement could produce different clinical symptoms in similar pathologic conditions.

Regarding external validity and generalizability issues of our study results, we could mention two points. First, our patients were not a specifically selected subgroup from those with CRS. Second, although the center where our patients were referred to was a large referral center for patients with CRS, we did not include patients from other geographically located hospitals in this study. Thus, we should be cautious in generalizing our results to all patients with CRS.

In conclusion, patients with higher symptom scores especially nasal scores are more likely to have CT imaging evidence of rhinosinusitis.

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