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Correlation of Lund-Mackay and SNOT-20 Before and After Functional Endoscopic Sinus Surgery (FESS): Does the Baseline Data Predict the Response Rate?

Background/Objective: To assess whether baseline SNOT-20 and Lund-Mackay score can predict response to FESS.

Materials and Methods: For 50 consecutive patients who underwent functional endoscopic sinus surgery (FESS) for chronic rhinosinusitis (CRS) in a university-affiliated hospital from January 2006 to February 2007, SNOT-20 and Lund-Mackay scores were evaluated preoperatively and after three months postoperatively.

Results: Pearson's correlation coefficient of the Lund-Mackay score and SNOT-20 score was 0.77 before FESS and 0.73 after FESS ($p < 0.001$). All multivariate regression models for evaluating whether the primary symptoms and CT scan findings predict the response rate showed a weak to moderate fitness to primary data based on all symptom domains and in each model, only the primary symptom domain of the dependent variable remain in the model.

Conclusion: The outcome of FESS in patients with CRS is moderately related to primary symptoms according to SNOT-20 as well as the Lund-Mackay radiologic score.

Keywords: Chronic Sinusitis, Endoscopic Sinus Surgery, Computed Tomography, Sinusitis Symptom Scores

Introduction

Chronic rhinosinusitis (CRS) is one of the most common chronic diseases with a significant impact on the quality of life and cost of health care in the world.[1] Despite the high prevalence, the pathogenesis of CRS remains elusive, and optimal strategies for the treatment are yet to be determined.

The definition of CRS is based principally on subjective data, incorporating the use of symptoms and signs that have been present for 12 weeks or more.[2,3] Although the identification of CRS is based on symptom and signs, many physicians use CT scan of the paranasal sinuses for the diagnosis of CRS. Kennedy proposed the need for staging systems in the evaluation of the extent of sino-nasal disease, as well as the outcome of treatments.[4] The American academy of otolaryngology has recommended the Lund and Mackay system for preoperative staging of CRS.[5]

The relative discordance between the patient's symptom scores and objective findings on computed tomography (CT) of the paranasal sinuses is one probable reason for controversy in the diagnosis and management of CRS.[6,7] Endoscopic sinus surgery is now established in the treatment of medically refractory CRS with excellent success rates on outcome.[8-12]

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There are varying reports of both positive and negative correlation between sino-nasal symptoms and CT evidence of CRS.[6,7,13,14] Many authors have concluded that CT scan findings are an important component of severity staging systems for CRS.[7,15-18]; although there is some evidence that findings on the CT scan do not correlate with the severity of CRS.[19,20] Several studies have reported the poor correlation between symptom scores and Lund-Mackay in CRS.[21] It has been proposed that patients with worse disease based on CT scan experience greater symptomatic improvement.[22] In this study, we aimed to evaluate the correlation between the degree and severity of symptoms as assessed by the SNOT-20 questionnaire and CT scan changes as graded by Lund-Mackay scoring system before and after functional endoscopic sinus surgery (FESS) and also to assess whether baseline SNOT-20 and Lund-Mackay scores can predict the response to FESS.

Patients and Methods

From January 2006 to February 2007, 50 consecutive patients, who underwent functional endoscopic sinus surgery (FESS) for CRS were enrolled in the study. The study protocol was approved by the institutional review board of our institution.

Chronic rhinosinusitis was diagnosed if the patients 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) posterior rhinorrhea and 4) headache/facial pain.[23]

All patients were treated with maximal medical therapy including nasal steroid, mucolytics, antibiotics when indicated, and none of them responded to these therapies. Patients with cystic fibrosis, immunodeficiency and ciliary dyskinesia were excluded in the present study. Also patients were excluded if they were unwilling or unable to undergo sinus CT scan.

All patients underwent preoperative sinus CT scan and were evaluated by the Lund-Mackay system.[5] Symptom scores and Lund-Mackay scores were evaluated preoperatively and after three months postoperatively. All CT scans were reviewed in a blinded system. The radiologist was blinded for the patient's symptoms and SNOT-20 scores and so was the physician who evaluated SNOT-20. Informed consent was obtained from all patients.

CT scans were performed by a Shimadzu (7800- JAPAN) system at 120KV and 150mA with 5mm intervals and a gantry tilt, a 2-second time and in the coronal plane (WW=400, WL=40; Bone window:WW= 1500, WL=450).

We categorized the SNOT-20 items in five domains and evaluated the correlation between each domain and Lund-Mackay scores. These domains consisted of the nasal symptom domain (need to blow nose, sneezing, running nose, thick nasal discharge); the oropharyngeal symptom domain (cough, PND, ear fullness, dizziness); the facial symptom domain (facial pain): the sleep-related symptom domain (difficulty falling sleep, wake up at night, lack of good night sleep, wake up tired); and the systemic symptom domain (fatigue, reduced productivity, reduced concentration, frustrated, sad, embarrassed).

All results were analyzed using SPSS ver 11.5. Correlation analysis was conducted to determine whether the CT scan stage as assigned by Lund Mackay staging system correlated with the SNOT-20 scores. Statistical significance was set at $p<0.05$.

Results

The study was performed on 50 patients who were candidates for FESS. The mean age of the patients was 32.4±8.5 years and 32 (64%) of the patients were male. In all patients the severity of sinusitis symptoms were measured by SNOT-20 questionnaire before and after the FESS; so for each symptom, the distribution of symptom grades was assessed before and after the procedure. The distribution of each SNOT-20 item before FESS is demonstrated in Table 1.

The mean of SNOT-20 was 45±8.7 (range: 29-67) before FESS. The mean of Lund-Mackay score before FESS was 18.5±5 (range: 8-24). Pearson's correlation coefficient of the Lund-Mackay score and the SNOT-20 score was 0.77 before FESS (p value<0.001).

Table 1. Distribution of Each SNOT-20 Item Before FESS

Individual Items	0	1	2	3	4	5	Mean
Need to blow nose	0	8	12	9	9	12	3.1±1.4
Sneezing	0	1	17	16	11	5	3±1
Runny nose	0	3	15	10	15	7	3.2±1.2
Cough	0	12	20	5	8	5	2.5±1.3
PND	0	0	6	11	11	22	4±1.1
Thick nasal discharge	0	0	6	17	12	15	3.7±1
Ear fullness	1	31	16	2	0	0	1.4±0.6
Dizziness	19	24	5	0	1	1	0.9±1
Ear pain	23	17	4	3	3	0	0.9±1.2
Facial pain	0	2	11	3	10	24	3.9±1.3
Difficulty falling asleep	4	21	17	5	3	0	1.6±1
Wake up at night	11	27	11	1	0	0	1±0.7
Lack of good night sleep	7	22	19	2	0	0	1.3±0.8
Wake up tired	4	27	6	1	10	2	1.8±1.4
Fatigue	2	2	14	8	22	2	3±1.2
Reduced productivity	3	7	5	14	10	11	3.1±1.5
Reduced concentration	3	22	21	4	0	0	1.5±0.7
Frustrated	4	20	18	8	0	0	1.6±0.9
Sad	0	17	13	14	5	1	2.2±1.1
Embarrassed	13	24	4	5	4	0	1.3±1.2

Table 2. Distribution of Each SNOT-20 Item After FESS

Individual Items	0	1	2	3	4	5	Mean
Need to blow nose	11	28	7	2	1	1	1.1±1
Sneezing	4	32	12	2	0	0	1.2±0.7
Runny nose	5	22	19	3	1	0	1.5±0.8
Cough	11	31	6	2	0	0	1±0.7
PND	2	19	18	5	5	1	1.9±1.1
Thick nasal discharge	2	17	19	8	3	1	1.9±1
Ear fullness	29	21	0	0	0	0	0.4±0.5
Dizziness	38	9	1	1	1	0	0.4±0.8
Ear pain	37	11	2	0	0	0	0.3±0.5
Facial pain	6	17	12	10	3	2	1.9±1.3
Difficulty falling asleep	24	17	7	2	0	0	0.7±0.9
Wake up at night	33	16	1	0	0	0	0.4±0.5
Lack of good night sleep	23	26	1	0	0	0	0.6±0.5
Wake up tired	31	14	5	0	0	0	0.5±0.7
Fatigue	5	23	18	3	1	0	1.4±0.8
Reduced productivity	7	15	18	6	4	0	1.7±1.1
Reduced concentration	25	23	2	0	0	0	0.5±0.6
Frustrated	30	18	2	0	0	0	0.4±0.6
Sad	18	25	5	2	0	0	0.8±0.8
Embarrassed	37	9	4	0	0	0	0.3±0.6

The distribution of each SNOT-20 item after FESS is mentioned in Table 2. The mean of SNOT-20 was 19±8.4 (range: 7-46) after FESS and the mean of Lund-Mackay score after FESS was 10.6±5.7 (range: 0-24). Pearson's correlation coefficient of the Lund-Mackay score and SNOT-20 score was 0.73 after FESS (p value<0.001). Also the correlation coefficients of the Lund-Mackay score and each individual item of

Table 3. Correlation Coefficients of the Lund-Mackay Score with Each Individual Item of the SNOT-20 Before and After FESS

Individual Items	Correlation Coefficient of the Item with Lund-Mackay Score Before FESS	P-Value	Correlation Coefficient of the Item with Lund-Mackay Score After FESS	P-Value
Need to blow nose	0.89	<0.001	0.67	<0.001
Sneezing	0.66	<0.001	0.47	0.001
Runny nose	0.50	<0.001	0.33	0.019
Cough	0.44	0.001	0.16	0.27
PND	0.56	<0.001	0.56	<0.001
Thick nasal discharge	0.35	0.011	0.40	0.004
Ear fullness	0.12	0.39	0.27	0.06
Dizziness	0.17	0.24	0.15	0.29
Ear pain	0.1	0.50	0.008	0.56
Facial pain	0.47	0.001	0.51	<0.001
Difficulty falling asleep	0.18	0.22	0.33	0.021
Wake up at night	-0.03	0.84	0.24	0.097
Lack of good night sleep	-0.27	0.06	-0.07	0.63
Wake up tired	0.30	0.03	0.27	0.063
Fatigue	0.40	0.004	0.45	0.001
Reduced productivity	-0.06	0.68	0.27	0.06
Reduced concentration	0.13	0.36	0.01	0.90
Frustrated	0.18	0.20	0.20	0.16
Sad	0.18	0.21	0.21	0.15
Embarrassed	0.14	0.32	0.30	0.035
Group items (Domains)				
Nasal domain	0.85	<0.001	0.74	<0.001
Oropharyngeal domain	0.62	<0.001	0.56	<0.001
Facial domain	0.63	<0.001	0.61	<0.001
Sleep domain	0.2	0.14	0.39	0.005
Systemic domain	0.35	0.011	0.58	<0.001

the SNOT-20 were calculated before and after FESS separately (Table 3).

None of the patients had aggravation of symptoms, in fact statistically in all patients, the SNOT-20 score lowered significantly after FESS ($p<0.001$) (Table 4).

The mean of SNOT-20 score was 45±8.7 (range: 29-67) before the procedure and 19±8.4 (range: 7-46) after FESS ($p<0.001$).

The mean decrease of SNOT was 26±8.2 (5-56) and the mean percentage of SNOT-20 decrease after FESS was 58.3%±13.9% (10.6%-86.1%). Statistically, the severity of all individual items of SNOT-20 was lowered significantly after the procedure (all p values <0.001). For all individual items of SNOT-20, the distribution of symptom decrease is shown in Table 4.

The mean of Lund-Mackay score was 18.5±5 (range: 8-24) before the FESS and 10.6±5.7 (range: 0-24) after FESS ($p <0.001$). In four patients (8%), the Lund-Mackay score did not have any change after FESS but in the others, the score lowered after the procedure (Table 5).

We assessed the correlation coefficient of each symptom domain with each other, and none of the coefficients were significant or at best, the value of coefficients were lower than 0.5.

All multivariate regression models for evaluating "do the primary symptoms and CT scan findings predict the response rate" showed a weak to moderate fitness to primary data based on all symptom domains; and in each model, only the primary symptom domain of the dependent variable remained in the model.

In the evaluation of "do the primary symptoms and CT scan predict the response rate", we assessed the multivariate regression models between the primary symptom domains and the response rate according to the SNOT-20 and SNOT-20 domains separately. In Table 6, the results of the multivariate regression

Table 4. Distribution of SNOT-20 Items Decrease After FESS

SNOT Items	Mean Reduction of the Score	Decrease Grade						P-Value
		0	1	2	3	4	5	
Need to blow nose	2.0±1.3	4	21	7	12	3	3	<0.001
Sneezing	1.8±1.0	2	22	14	8	4	0	<0.001
Runny nose	1.7±0.8	1	23	16	10	0	0	<0.001
Cough	1.5±1.1	5	29	6	7	2	1	<0.001
PND	2.1±1.0	1	15	17	13	4	0	<0.001
Thick nasal discharge	1.8±0.8	1	17	24	7	1	0	<0.001
Ear fullness	1.0±0.5	8	36	6	0	0	0	<0.001
Dizziness	0.5±0.5	26	23	1	0	0	0	<0.001
Ear pain	0.6±0.8	27	17	4	2	0	0	<0.001
Facial pain	2.0±1.1	3	14	18	12	1	2	<0.001
Difficulty falling asleep	0.9±0.5	8	39	3	0	0	0	<0.001
Wake up at night	0.7±0.6	18	30	2	0	0	0	<0.001
Lack of good night sleep	0.8±0.6	17	28	5	0	0	0	<0.001
Wake up tired	1.4±1.0	10	23	8	7	2	0	<0.001
Fatigue	1.6±1.0	6	14	23	6	1	0	<0.001
Reduced productivity	1.4±0.9	10	16	19	5	0	0	<0.001
Reduced concentration	1.0±0.7	11	30	8	1	0	0	<0.001
Frustrated	1.2±0.8	8	30	8	4	0	0	<0.001
Sad	1.4±0.9	7	21	19	2	1	0	<0.001
Embarrassed	0.9±0.8	17	22	9	2	0	0	<0.001

models have been mentioned.

The extent of CT scan finding improvement was assessed regarding the degree of clinical symptom improvement. For this purpose, we considered the difference of Lund-Mackay improvement as a dependent variable and the difference of clinical symptoms as independent variables (systemic, facial, sleep, or pharyngeal and nasal improvement). The r^2 of the model was 0.47 ($p<0.001$) and the coefficients are demonstrated in Table 7.

Therefore, only nasal improvement remained a significant variable in the model.

Discussion

Chronic rhinosinusitis is a great problem resulting in patient morbidity and large health care costs. The degree of CRS may be classified by endoscopic appearance, presence of systemic diagnosis and CT score according to the system described by Lund and Mackay.[6] There are several staging systems and Lund-Mackay system is the most popular. We used Lund-Mackay system for the CT scan stage and SNOT-20 for the evaluation of symptom scores in this study. Endoscopic sinus surgery is an effective treatment modality for medically refractory CRS with good symptomatic outcomes in long term follow-up.[8,9]

Correlation between SNOT-20 and Lund-Mackay

Many studies have shown a lack of correlation between the CT scan stage and symptom scores.[7,18] In 2005, Bradley and Kauntakis reported that the severity of rhinosinusitis on preoperative CT-scan does not predict the severity of symptoms assessed by the SNOT-20 inventory in patients who were candidates for functional endoscopic sinus surgery.[22]

Bhattacharyya et al. reported their findings of 221 patients referred for assessment of chronic rhinosinusitis.[7] They compared SNOT-20 and CT-scan with respect to the severity of mucosal thickening. The authors found no significant correlation between the severity score measures in CT and SNOT-20. In their study patients with significant facial pain symptoms had lower mean CT severity scores.[7]

Stewart and colleagues reported on correlations between symptom scores and CT findings of 254 patients.[18] They conducted their study using CT scan

Table 5. Changes of Lund-Mackay Scores After FESS

Preprocedure Lund-Mackay Score	Frequency	Post procedure Lund-Mackay Score	Frequency
8	2	0	1
		7	1
9	1	1	1
10	2	1	1
		9	1
11	1	3	1
12	2	4	1
		5	1
13	3	2	1
		4	1
		6	1
14	1	7	1
16	2	8	1
		9	1
17	2	8	1
		10	1
18	12	7	3
		8	1
		10	1
		11	2
		12	1
		15	2
		18	2
22	9	5	1
		8	1
		9	1
		11	2
		12	1
		14	1
		16	2
23	1	11	1
24	12	9	2
		11	1
		12	1
		15	2
		16	1
		18	2
		22	1
		24	2

staging systems (Lund-Mackay and Harvard system) and two symptom severity measures (chronic sinusitis survey and the sinonasal outcome test-20) in which they found no correlation between CT-scan and symptom scores.[18]

In our study, compared to other studies, we found good correlation between the patients' symptoms and CT-scan findings. We did not find any other studies regarding the correlation between patients' symptoms and CT scan findings after FESS, but we found a good correlation between patients' symptoms and CT scan findings after FESS.

In this study, we obtained six multivariate models for the prediction of each symptom domain improvement and the SNOT-20 improvement.

According to r^2 of models all had a weak or moderate power for prediction of the symptom improvement. In this relation, primary CT scan findings based on Lund-Mackay were not statistically significant in all models, but reviewing all models for each symptom domain improvement, only its baseline score remains in the model [for example in multivariate model for the prediction of nasal score improvement, only primary nasal score remained in the model (model coefficient =0.58, p value =0.014)].

Based on the results of this study, all symptom domains (if present) improved after the FESS; however, due to the weak correlation between primary symptom domains in each patient, the improvement of each symptom domain was correlated only with its baseline symptom.

In this study, the mean percent of SNOT-20 and Lund-Mackay decrease after FESS was lower than some studies[22] ($p< 0.001$). This could be due to the fact that the baseline SNOT-20 score and Lund-Mackay score for our patients was higher than those studies. (45 ± 8.7 in comparison to 30.6 ± 1.8 for SNOT-20 and 18.5 ± 5 in comparison to 13.2 ± 0.8 for Lund-Mackay; both $p< 0.001$).

Does baseline data predict the response rate?

From patient to patient, there may be a significant difference in symptom improvement after FESS. Thus, it is important to have a protocol for predicting the probable outcome of FESS. Caldwell suggested a staging system is necessary for the evaluation of surgery outcome.[24] Relationship between preoperative CT score and clinical outcome after FESS has been reported by some authors.

Marks and Shamsa found that a previous sinus sur-

Table 6. Results of the Multivariate Regression Models

Independent Variable / Dependent Variable	Model R Square	Model P-Value	Constant (P-Value)	LMCKAY Pre (P-Value)	NASAL pre (P-Value)	SLEEP Pre (P-Value)	SYS Pre (P-Value)	OROPH Pre (P-Value)	FACIAL pre (P-value)
Nasal difference	0.51	<0.001	-.761 (0.67)	-.102 (0.47)	.582 (0.014)	.004 (0.98)	.036 (0.82)	.280 (0.14)	-.216 (0.56)
Sleep difference	0.40	0.001	1.76 (0.073)	-0.1 (0.19)	-0.057 (0.64)	0.35 (<0.001)	0.093 (0.25)	0.14 (0.19)	0.002 (0.99)
Systemic difference	0.29	0.018	1.7 (0.39)	-0.15 (0.33)	-0.16 (0.51)	-0.23 (0.90)	0.43 (0.011)	0.39 (0.06)	0.41 (0.31)
Oropharyngeal difference	0.57	<0.001	1.75 (0.18)	-.074 (0.47)	-0.15 (0.36)	.045 (0.71)	-.079 (0.4)	.76 (<0.001)	.16 (0.54)
Facial difference	0.33	0.006	-0.21 (0.79)	-0.08 (0.20)	-0.027 (0.79)	-0.042 (0.57)	0.006 (0.92)	0.16 (0.022)	0.60 (<0.001)
SNOT difference	0.38	0.002	4.2 (0.45)	-0.51 (0.26)	0.18 (0.80)	0.34 (0.52)	0.48 (0.31)	1.76 (0.004)	0.96 (0.41)

Table 7. Regression Model Coefficients Predicting Lund-Mackay Improvement Based on Symptom Domain Improvement

Improvement of Clinical Symptom Domain	Coefficient	P-Value
Nasal improvement	0.52	0.037
Sleep improvement	-0.61	0.12
Systemic improvement	0.20	0.47
Oropharyngeal improvement	0.49	0.11
Facial improvement	0.39	0.50
Constant	1.29	0.41

gery adversely affected the prognosis.[25] Sharp et al. discovered that the results of endoscopic sinus surgery in patients with CRS were related to the Lund-Mackay CT score system.

In a study conducted on 120 patients who had undergone endoscopic sinus surgery and were followed up for 18 months after the procedure, Kennedy concluded that there was a significant relationship between the extent of CRS and the surgical outcome.[4] He evaluated patients using 250 data fields covering symptomatology, CT scoring and endoscopic findings.

In another study performed on multivariate analysis by Stewart and his colleagues, they found a significant association between preoperative CT score and the percentage of change in sinonasal symptoms (measured by chronic sinusitis survey) and also a relationship between the CT stage (Harvard system) before ESS and the postoperative system score.[26] They reported that patients with bilateral nasal polyps had better improvement in symptom scores.[26]

In contrast to Stewart, some studies reported a discrepancy between CT scan findings and improvement in symptom scores after FESS.[8,27,28]

Battacharyya in a study conducted on 161 CRS patients, concluded that the CT scan stage alone can not predict symptom outcomes after ESS.[11]

According to our results, we can predict that patients with a more severe disease on CT scan will have better symptom improvement after treatment. This means that patients with a severe disease before treatment may get more symptomatic improvement after FESS than patients with a mild disease diagnosed in CT.

One cause of different results in the literature concerning symptom correlations by CT findings is that different investigators have used heterogeneous populations for the study with some investigators studying symptom correlations between patients referred for the evaluation of CRS (all-comers) and others examining patients considered for surgery.

The second reason for the differences may be due to different methods of symptom assessment in these patients (SNOT-20 versus CSS or SNAQ). The third factor is the different method of evaluating and scoring CT scans (Lund-Mackay versus Harvard system).

One limitation of our study was a relatively small

sample. The study should be achieved in a larger multicenteric patient group.

In conclusion, the results have shown that the outcome of FESS in patients with CRS is related to the symptoms according to SNOT-20 as well as the Lund-Mackay radiologic score.

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