ORIGINAL ARTICLE

Diagnostic accuracy of sino-nasal outcome test-22 and lund-kennedy endoscopic score for chronic rhinosinusitis in pre-bone marrow transplantation assessment

Abolfazl Taheri[1], Arvin Shahzamani[2], Mahboobe Asadi[3]

[1]Department of Otorhinolaryngology, Baqiyatallah University of Medical Sciences, Tehran, Iran, [2] Student Research Committee, Baqiyatallah University of Medical Sciences, Tehran, Iran, [3]Department of Otorhinolaryngology, Head and Neck Surgery, Taleghani Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Background: The diagnosis of chronic rhinosinusitis (CRS) is a crucial and challenging entity in bone marrow transplantation candidates. We aimed to evaluate the diagnostic accuracy of the Sino-Nasal Outcome Test (SNOT-22) and Lund-Kennedy endoscopic score for the diagnosis of CRS in bone marrow transplantation candidates. **Materials and Methods:** We conducted a single-center, observational study evaluating bone marrow transplantation candidates by paranasal sinus computed tomography (CT) scan without contrast to measure the Lund Mackay score. Patients with a Lund Mackay score higher than or equal to four or with any evidence of sino-nasal fungus ball in their paranasal sinus CT were considered CRS. The Lund Kennedy endoscopic score and SNOT-22 were also calculated for all participants. **Results:** This study included 495 patients, of which 63 were diagnosed with CRS. Participants had a median age of 40 (30, 57) years old and 51.3% were male. The Lund Kennedy score and SNOT-22 were correlated with the Lund Mackay score. Furthermore, both SNOT-22 and Lund Kennedy scores were the predictors of CRS based on univariate logistic regression (odds ratio [95% confidence interval (CI)]: 1.10 [1.06, 1.15], 1.37 [1.22, 1.56], respectively). Lund Kennedy score ≥1 had a sensitivity of 0.78 (95% CI: 0.66, 0.87) and a specificity of 0.76 (95% CI: 0.52, 0.83) (AUC [95% CI]: 0.81 [0.75, 0.87]), while SNOT-22 did not yield a remarkable diagnostic accuracy. **Conclusion:** The Lund-Kennedy endoscopy score could diagnose CRS in bone marrow transplantation candidates with satisfactory accuracy, whereas SNOT-22 lacks enough accuracy to be employed as an independent sino-nasal assessment modality in these patients.

Key words: Bone marrow transplant, chronic rhinosinusitis, lund kennedy score, lund mackay score, sino-nasal outcome test-22

How to cite this article: Taheri A, Shahzamani A, Asadi M. Diagnostic accuracy of sino-nasal outcome test-22 and lund-kennedy endoscopic score for chronic rhinosinusitis in pre-bone marrow transplantation assessment. J Res Med Sci 2024;29:67.

INTRODUCTION

Chronic rhinosinusitis (CRS) is characterized by an inflammatory condition of the paranasal sinuses.[1] According to the recent literature, the prevalence of CRS is estimated to be over 10%; nonetheless, it has great geographical variation.[2,3] The diagnosis of CRS is based on the presence of at least two major symptoms for at least 12 weeks and either endoscopic signs or computed tomography (CT) scan evidence suggestive of the disease.[4] CRS is more common in immunodeficient patients, mostly in humoral immune deficiency. CRS in secondary immune deficiency, one of its most severe forms being chemotherapy, is less studied compared to primary immune deficiencies.[5]

Bone marrow transplantation is one of the key treatments for various hematological disorders. Bone marrow transplant candidates are immunocompromised due to both the underlying disease and the bone marrow transplantation.[6] Therefore, these patients are predisposed to different types of infection: paranasal sinusitis, being one of the most

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jrms

DOI: 10.4103/jrms.jrms_149_24

Address for correspondence: Dr. Abolfazl Taheri, Department of Otorhinolaryngology, Baqiyatallah University of Medical Sciences, Tehran, Iran. E-mail: dr.abolfazl.taheri@gmail.com

Submitted: 18-Mar-2024; **Revised:** 28-May-2024; **Accepted:** 18-Jun-2024; **Published:** 28-Nov-2024

common infections in the general population, is concerning in this patient population.[6,7] Up to 44% of patients experience posttransplantation sinusitis.[6] Pretransplant screening for rhinosinusitis using paranasal sinus CT scan is recommended and practiced in many transplant centers; however, evidence is limited regarding the value of pretransplant CT scan and its impact on mortality and morbidity.[6-8]

Evidence suggests that symptoms and Lund-Kennedy endoscopic score and symptoms in symptomatic CRS patients are highly correlated with the Lund-Mackay score.[3] Recently, a novel approach has been suggested for prebone marrow transplantation sino-nasal assessment. It has suggested set-wise use of clinical symptoms, Diagnostic Nasal Endoscopy (DNE), and paranasal sinus CT scan to reduce cost and radiation.[9] Nonetheless, the evidence lacked specific clinical criteria for the diagnosis or set-wise sino-nasal assessment in terms of clinical symptoms in this patient population. Therefore, in this study, we aimed to compare the diagnostic value of the Sino-Nasal Outcome Test (SNOT-22) and Lund-Kennedy endoscopic score with paranasal sinus CT scan for pretransplant assessment of CRS in bone marrow transplant candidates.

MATERIALS AND METHODS

Study design

We conducted a single-center, cross-sectional study at the otolaryngology clinic of Baqiyatallah Hospital, Baqiyatallah University of Medical Sciences, Tehran, Iran, from April 2023 to September 2023. This study was approved by the ethics committee of Baghiyatallah University of Medical Sciences, Tehran, Iran (ethical approval ID: IR.BMSU.REC.1402.078). Written informed consent was obtained from all the participants before participation in the study. None of the participants was burdened with any additional cost for participation in this study.

Participants

We consecutively enrolled all eligible patients who were referred to our otolaryngology clinic and were willing to participate in this study according to the inclusion and exclusion criteria. The inclusion criteria consisted of the following: (1) Immunocompromised patients with hematological disease, (2) candidate for bone marrow transplantation, and (3) willing to participate. Patients were excluded if they had any symptoms of acute rhinosinusitis.

Data collection

The patient's demographic information (i.e., age and hematologic disease) was recorded, and each patient filled out the SNOT-22 and the SNOT-22 score was also recorded. SNOT-22 is a validated questionnaire composed of 22 items scored from 0 to 5 based on the severity of the symptom. The total score of SNOT-22 ranges from 0 to 110.[10] A 0.91 Cronbach's alpha score and 0.93 test-retest reliability coefficient were reported in the literature for the SNOT-22.[11]

The Lund-Kennedy endoscopy score was also measured during the DNE performed by a single expert otolaryngologist. After preparing the nasal cavity by packing it with cotton soaked with 4% lidocaine and 1:200000 epinephrine for 7–10 min, DNE was performed using a 4-mm rigid endoscope (Stor, Tuttlingen, Germany) with a 0° angle. Each nasal cavity was assessed regarding nasal polyp, discharge, edema, scarring, and crusting. Then, the Lund-Kennedy score was calculated as described in the literature.[12]

All patients underwent paranasal sinus CT scan without contrast. Subsequently, the Lund-Mackay score was calculated using the paranasal sinus CT scan by two independent otolaryngologists, and any disagreement was resolved by discussion. Lund-Mackay score was calculated as described previously in the literature.[13]

Participants were divided into two groups according to the presence or absence of CRS. Patients were considered to have CRS if they had a Luna-Mackay score equal to or higher than four or had any evidence of sino-nasal fungus ball in their paranasal sinus CT scan. The presence of the sino-nasal fungus ball was assessed by two independent otolaryngologists according to the available literature, and any disagreement was resolved by discussion.[14-18]

Statistical analysis

The continuous variables were presented as median (Interquartile range) for nonparametric variables and categorical variables were presented as percentage (frequency). The normality of the distribution of continuous variables was evaluated by plotting and Shapiro–Wilk's test. Given none of the continuous variables was normally distributed, the Mann–Whitney *U*-test was employed to compare the continuous variables. In addition, a Chi-squared test was employed for the categorical variables if none of the expected values were <5; otherwise, a Fisher exact test was performed. The correlations were assessed using the Spearman correlation tests. A univariate logistic regression model was designed for each outcome variable to predict CRS. All statistical analyses were performed by R using R Studio software (version 4.2.2.) The RStudio IDE is developed by Posit, PBC [19] using "tidyverse,"[20] "ggpubr,"[21] "DescTools,"[22] "rstatix,"[23] and "pROC"[24] R packages.

RESULTS

A total of 495 patients enrolled in this study, of which

63 were diagnosed with CRS and 432 did not have CRS according to the CT scan of paranasal sinuses. The median age of participants was 40 (30, 57) years old and 51.3% (254) were male. The endoscopy, CT scan, and clinical data were collected from all included patients, and no missing values were present. The demographic characteristics and primary diseases of the participants are presented in Table 1.

The clinical findings of the participants were collected using the SNOT-22 questionnaire. The median SNOT-22 score of participants was 0 (0, 8). The Lund-Mackay score was calculated according to the CT scan of the paranasal sinuses, and the Lund-Kennedy score was measured based on the DNE. The SNOT-22 score and Lund-Kennedy score were significantly higher in patients diagnosed with CRS, compared to patients without a diagnosis of CRS [Table 2].

The SNOT-22 and Lund-Kennedy endoscopy scores were strongly correlated (r: 0.62, $P < 0.001$), whereas the correlations between these scores and the Lund-Mackay score were weak (r: 0.37, $P < 0.001$; r: 0.38, $P < 0.001$, respectively). Univariate logistic regression models demonstrated that the SNOT-22 and Lund-Kennedy endoscopy scores were both significant predictors of CRS (odds ratio [95% confidence interval (CI)]: 1.10 [1.06, 1.15], 1.37 [1.22, 1.56], respectively), as presented in Table 3. However, the strong correlation between Lund-Kennedy and SNOT-22 scores precluded a multiple logistic regression model.

The Lund-Kennedy endoscopy score equal to or higher than one yielded a sensitivity of 0.78 (95% CI: 0.66, 0.87) and a specificity of 0.76 (95% CI: 0.52, 0.83) (AUC [95% CI]: 0.81 [0.75, 0.87]) [Table 4]. The Lund-Kennedy score ≥1 had 105 false positives and 14 false negatives. The SNOT-22 score yielded a poor discrimination (AUC [95% CI]: 0.64 [0.57, 0.71]). The receiver operating characteristic (ROC) curves are presented in Figure 1.

Table 1: Demographic characteristics of patients in total and divided according to the presence of chronic rhinosinusitis

Variable	Total (*n*=495), *n* (%)	CRS (*n*=63), *n* (%)	Non-CRS (*n*=432), *n* (%)	*P*
Age, median (IQR)	40 (30-57)	47 (33.5-59)	40 (30-56)	0.16
Gender				
Male	254 (51.3)	35 (55.5)	219 (50.7)	0.56
Female	241 (48.7)	28 (44.4)	213 (49.3)	
Disease				
ALL	25 (5.0)	2 (3.2)	23 (5.3)	0.20
AML	83 (16.8)	6 (9.5)	77 (17.8)	
AA	11 (2.2)	3 (4.8)	8 (1.8)	
CLL	1 (0.2)	0	1.(0.2)	
CML	16 (3.2)	5 (7.9)	2.5 (11)	
Hodgkin lymphoma	20.6 (102)	12 (19.0)	20.8 (90)	
NonHodgkin lymphoma	16.6 (82)	10 (15.9)	72 (16.7)	
Multiple myeloma	174 (35.1)	25 (39.7)	149 (34.5)	
Myelofibrosis	1 (0.2)	0	1 (0.2)	

CRS=Chronic rhinosinusitis; IQR=Interquartile range; ALL=Acute lymphocytic leukemia; AML=Acute myeloid leukemia; CLL=Chronic lymphocytic leukemia; CML=Chronic myeloid leukemia; AA=Aplastic anemia

DISCUSSION

Sino-nasal assessment regarding CRS is recommended before bone marrow transplantation.[6-8] A novel step-wise approach has been suggested for sino-nasal assessment before bone marrow transplantation.[9] However, it lacks specific clinical criteria regarding clinical symptoms. Therefore, we aimed to evaluate the diagnostic value of the SNOT-22 and Lund-Kennedy endoscopy score for the diagnosis of CRS in prebone marrow transplantation sino-nasal assessment.

We found a strong, significant correlation between the SNOT-22 score and the Lund-Kennedy score. Both Lund-Kennedy and SNOT-22 scores were the predictors of CRS based on the univariate logistic regression. Moreover, we found that a Lund-Kennedy score equal to or higher than one could diagnose CRS with satisfactory accuracy, while the SNOT-22 did not yield satisfactory diagnostic accuracy.

Consistent with our results, positive DNE findings were correlated with paranasal sinus CT scan findings.[25] The DNE could be beneficial in the diagnosis of CRS without a paranasal sinus CT scan, thus minimizing the utilization of a CT scan. A Lund-Kennedy score of one or higher diagnoses CRS with a specificity of 76%; therefore, CRS diagnosis could be considered without a CT scan in bone marrow transplantation candidates with a Lund-Kennedy score of one or higher. On the contrary, SNOT-22 could not be employed as a standalone sino-nasal assessment of bone

Table 2: Computed tomography scan, endoscopy, and clinical findings of all patients and divided by the presence of chronic rhinosinusitis

Variable	Total, (*n*=495)	CRS, (*n*=63)	Non-CRS, (*n*=432)	*P*
Lund-Mackay CT score, median (IQR)	0 (0-1)	7 (4-10)	0 (0-0)	<0.001*
Lund-Kennedy endoscopy score, median (IQR)	0 (0-1)	2 (1-3)	0 (0-0)	<0.001*
SNOT-22 score, median (IQR)	0 (0-8)	3 (0-10)	0 (0-7)	<0.001*

CT=Computed tomography; IQR=Interquartile range; CRS=Chronic rhinosinusitis; SNOT-22=Sino-nasal outcome test

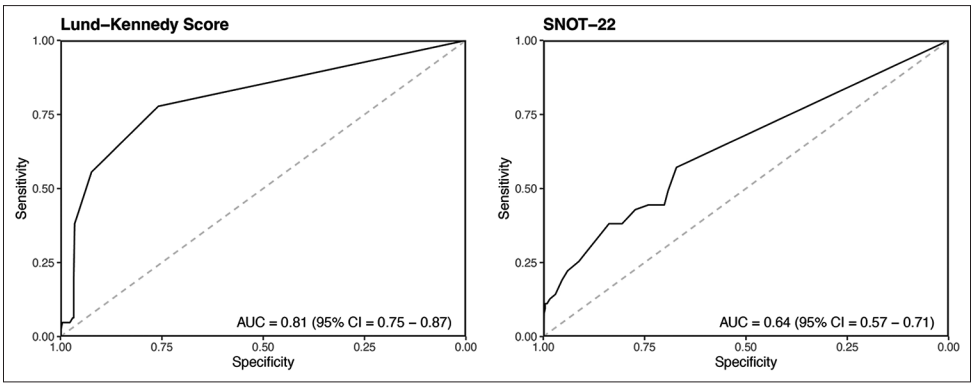

Figure 1: The receiver operating characteristic curves for sino-nasal outcome test-22 and Lund-Kennedy score. CI: Confidence interval

Table 3: Univariate logistic regression model to detect chronic rhinosinusitis

Variable	β (SE)	OR (95% CI)	*P*
Lund-Kennedy endoscopy score	0.32 (0.06)	1.37 (1.22–1.56)	<0.001*
SNOT-22 score	0.10 (0.02)	1.10 (1.06–1.15)	<0.001*

CI=Confidence interval; SE=Standard error; SNOT-22=Sino-nasal outcome test; OR=Odds ratio

Table 4: Contingency table of test results according to Lund-Kennedy score

	CRS, *n* (%)	Non-CRS, *n* (%)	*P*
Lund-Kennedy score ≥1	49 (77.8)	105 (24.3)	<0.001
Lund-Kennedy score <1	14 (22.2)	327 (75.7)	

CRS=Chronic rhinosinusitis

marrow transplantation candidates, as it lacks sufficient sensitivity and specificity. It is noteworthy that the preferred initial imaging is a paranasal sinus CT scan if invasive fungal sinusitis is suspected.[9,16]

Recent studies on CRS patients without an underlying disease demonstrated that the Visual Analog Scale assessing clinical symptoms was strongly correlated with the Lund-Mackay score, and this correlation was stronger than that of Lund-Kennedy and Lund-Mackay scores.[3] On the other hand, the Lund-Kennedy endoscopy score and Lund-Mackay CT scan score were significantly correlated in patients with cystic fibrosis who are also prone to CRS, while the questionnaires alone lacked sufficient diagnostic yield.[26] Therefore, it seems that the value of clinical symptoms in the assessment of CRS might differ in various patient populations according to their underlying disease. Our findings are in agreement with those of patients with underlying cystic fibrosis.

Evidence suggests that DNE yields a high sensitivity for the diagnosis of CRS in symptomatic patients with no underlying disease while yielding an unsatisfactory specificity.[25] According to our findings, the Lund-Kennedy endoscopy score yielded an acceptable sensitivity and specificity for diagnosing CRS in bone marrow transplantation candidates. The available literature shows untreated CRS increases mortality after liver transplantation.[27] Moreover, in patients who are candidates for bone marrow transplantation, the timely diagnosis of CRS before transplantation is crucial, and this timely diagnosis and treatment are especially important in fungal rhinosinusitis.[28] Therefore, the sensitivity of the diagnostic or screening modalities for prebone marrow transplantation assessment is of substantial importance.

In line with our findings, most recent literature does not recommend a paranasal sinus CT scan for all patients as a part of sino-nasal assessment before bone marrow transplantation.[9] Furthermore, bone marrow transplantation candidates with absolute neutrophil count lower than 500/m^3 had a lower Lund-Mackay CT scan score when experiencing rhinosinusitis.[29] Therefore, the aforementioned approaches should be employed with caution in this patient population.

Limitations

Sino-nasal fungus ball was diagnosed by CT scan and DNE, given this study was conducted before surgical intervention and obtaining histology sample. The surgically obtained histopathology is the gold standard of fungus ball diagnosis and the lack of follow-up in the current study precluded us from employing this diagnostic modality. In addition, our study lacks a posttransplantation follow-up to assess the predictive value of the Lund-Kennedy endoscopy score and SNOT-22 for the prediction of posttransplantation rhinosinusitis.

CONCLUSION

We found that the Lund-Kennedy endoscopy score could diagnose CRS in bone marrow transplantation candidates with satisfactory accuracy, while SNOT-22 should not be employed as a standalone sino-nasal assessment modality.

Data availability statement

The data that support the findings of this study are available from the corresponding author, (A.S.), upon reasonable request.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Sedaghat AR. Chronic rhinosinusitis. Am Fam Physician 2017;96:500-6.
2. Sedaghat AR, Kuan EC, Scadding GK. Epidemiology of chronic rhinosinusitis: Prevalence and risk factors. J Allergy Clin Immunol Pract 2022;10:1395-403.
3. Baba Caliaperoumal VB, Gs D, Velayutham P, Krishnaswami B, Rama Krishnan KK, Savery N. Correlation of clinical symptoms with nasal endoscopy and radiological findings in the diagnosis of chronic rhinosinusitis: A prospective observational study. Cureus 2021;13:e16575.
4. Bachert C, Pawankar R, Zhang L, Bunnag C, Fokkens WJ, Hamilos DL, *et al.* ICON: Chronic rhinosinusitis. World Allergy Organ J 2014;7:25.
5. Chiarella SE, Grammer LC. Immune deficiency in chronic rhinosinusitis: Screening and treatment. Expert Rev Clin Immunol 2017;13:117-23.
6. Drozd-Sokolowska JE, Sokolowski J, Wiktor-Jedrzejczak W, Niemczyk K. Sinusitis in patients undergoing allogeneic bone marrow transplantation – A review. Braz J Otorhinolaryngol 2017;83:105-11.
7. Martin J, Welch KC. Sinonasal evaluation preceding hematopoietic transplantation. Otolaryngol Head Neck Surg 2017;143:P137-8.
8. Fulmer S, Kim SW, Mace JC, Leach ME, Tarima S, Xiang Q, *et al.* Hematopoietic stem cell transplantation and rhinosinusitis: The utility of screening sinus computed tomography. Laryngoscope 2012;122:2647-51.
9. Ghazizadeh M, Mehrparvar G, Ghazizadeh M. An algorithmic approach to sinonasal evaluation preceding bone marrow transplantation. Otolaryngol Pol 2023;77:7-13.
10. Liu M, Liu J, Weitzel EK, Chen PG. The predictive utility of the 22-item sino-nasal outcome test (SNOT-22): A scoping review. Int Forum Allergy Rhinol 2022;12:83-102.
11. Hopkins C, Gillett S, Slack R, Lund VJ, Browne JP. Psychometric validity of the 22-item sinonasal outcome test. Clin Otolaryngol 2009;34:447-54.
12. DeConde AS, Bodner TE, Mace JC, Alt JA, Rudmik L, Smith TL. Development of a clinically relevant endoscopic grading system for chronic rhinosinusitis using canonical correlation analysis. Int Forum Allergy Rhinol 2016;6:478-85.
13. Hopkins C, Browne JP, Slack R, Lund V, Brown P. The lund-mackay staging system for chronic rhinosinusitis: How is it used and what does it predict? Otolaryngol Head Neck Surg 2007;137:555-61.
14. Bhattacharyya N. A comparison of symptom scores and radiographic staging systems in chronic rhinosinusitis. Am J Rhinol 2005;19:175-9.
15. Bhattacharyya N, Fried MP. The accuracy of computed tomography in the diagnosis of chronic rhinosinusitis. Laryngoscope 2003;113:125-9.
16. DelGaudio JM, Swain RE Jr., Kingdom TT, Muller S, Hudgins PA. Computed tomographic findings in patients with invasive fungal sinusitis. Arch Otolaryngol Head Neck Surg 2003;129:236-40.
17. Seo YJ, Kim J, Kim K, Lee JG, Kim CH, Yoon JH. Radiologic characteristics of sinonasal fungus ball: An analysis of 119 cases. Acta Radiol 2011;52:790-5.
18. Dhong HJ, Jung JY, Park JH. Diagnostic accuracy in sinus fungus balls: CT scan and operative findings. Am J Rhinol 2000;14:227-31.
19. Team RS. RStudio: Integrated Development Environment for R. (No Title); 2021.
20. Wickham H, Averick M, Bryan J, Chang W, McGowan LD, François R, *et al.* Welcome to the Tidyverse. J Open Source Softw 2019;4:1686.
21. Kassambara A, Kassambara MA. Package 'ggpubr'. R Package Version 0.1. 2020;6.
22. Signorell A, *et al*. DescTools: Tools for descriptive statistics. R Package Version 0.99, 2021;41.
23. Kassambara A. rstatix: Pipe-friendly framework for basic statistical tests. R package version 0.7. 0.
24. Robin X, Turck N, Hainard A, Tiberti N, Lisacek F, Sanchez JC, *et al.* PROC: An open-source package for R and S+ to analyze and compare ROC curves. BMC Bioinformatics 2011;12:77.
25. Kolethekkat AA, Paul RR, Kurien M, Kumar S, Al Abri R, Thomas K. Diagnosis of adult chronic rhinosinusitis: Can nasal endoscopy predict intrasinus disease? Oman Med J 2013;28:427-31.
26. Boari L, Castro Júnior NP. Diagnosis of chronic rhinosinusitis in patients with cystic fibrosis: correlation between anamnesis, nasal endoscopy and computed tomography. Rev Bras Otorrinolaringol 2005;71:705-10.
27. Oh JS, Kim MS, Kim SH, Kim JH. Incidence and treatment outcome of rhinosinusitis before kidney transplantation: A retrospective cohort study. J Pers Med 2021;11:553.
28. Gariuc L, Sandul A, Daniel L. Invasive fungal rhinosinusitis. Rom J Rhinol 2019;9:13-9.
29. Sekine L, Manica D, Piltcher OB, Lopes CJ, Segatto MM, Paz AA, *et al*. Rhinosinusitis in autologous and allogeneic bone marrow transplantation: a retrospective study on the performance of imaging studies on severity and prognostic evaluation. Rev Bras Hematol Hemoter 2010;32:29-33.