

Changes of nasalance scores in patients with chronic rhinosinusitis

Yi-An Pan, MD¹ , Ying-Piao Wang, MD, MS, PhD^{1,2,3} , Yi-Chen Chen, MSc, SLP⁴ and Li-Chun Hsieh, MD, PhD^{1,2,3}

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Chronic rhinosinusitis (CRS) is a prevalent inflammatory disease of the paranasal sinuses. Hong et al.¹ had reported significantly lower nasalance scores for nasal sentences in patients with CRS compared to normal adults. Otherwise, recent studies have primarily focused on comparing the changes in the nasalance scores of patients with CRS before and after sinonasal surgeries.^{2,3} There is a lack of in-depth investigations on the differences between the nasalance of patients with CRS and healthy subjects.

The aim of this study was to analyze the influence of CRS on nasalance scores and to investigate the correlation between the severity of CRS and the nasalance scores.

Patients and methods

Participants

The inclusion criteria for patients with CRS were as follows: (1) adult native Mandarin speaker, (2) negative past history of craniofacial anomalies, (3) negative history of oral and nasal surgery, and (4) the diagnosis of bilateral CRS meets the criteria of European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS) 2012 edition.⁴ Seventy participants were enrolled.

¹Department of Otolaryngology–Head and Neck Surgery, MacKay Memorial Hospital, Taipei, Taiwan; ²School of Medicine, MacKay Medical College, New Taipei City, Taiwan; ³Department of Audiology and Speech Language Pathology, MacKay Medical College, New Taipei City, Taiwan; ⁴Department of Special Science, University of Taipei, Taipei, Taiwan

Correspondence to: Li-Chun Hsieh, MD, PhD, Department of Otolaryngology–Head and Neck Surgery, MacKay Memorial Hospital, Address: No. 92, Sec. 2, Zhongshan N. Rd., Taipei City 10449, Taiwan. Email: lichunhsieh1978@gmail.com

Y.A.P. and Y.P.W. were co-first authors of this study.

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Classification of CRS severity

The severity of CRS was classified using the Meltzer polyp grading system,⁵ Lund-Mackay CT scores (LMCTS),⁶ and subjective nasal obstruction visual analogue scale (NOVAS).⁷ A sinuscope was used to assess the extent of nasal polyps for each nostril, which ranged from 0 to 4. The final polyp grading score, which was obtained by adding the results of Meltzer polyp grading of both sides, ranged from 0 to 8 (no polyp: 0, mild: 1 to 2, moderate 3 to 5, and severe 6 to 8).

Standard passage speech stimuli

The oral passage, mixed passage, and nasal sentences were 71 syllables, 72 syllables, and 42 syllables in length, respectively.^{8,9} The percentage of nasal phonemes was 0% in the oral passage, 19.9% in the mixed passage, and 32.6% in the nasal sentences.

Nasometer data collection

The Nasometer KayPentax II Model 6400 (Pentax Medical, Singapore) was used to record and analyze the level of nasalance in the study. It was calibrated and set up according to the 2008 edition of the nasometer guidebook.

Statistics

We used 1-way analysis of variance (ANOVA) to compare the nasalance scores of the 3 speech stimuli. Spearman linear regression was used to analyze the correlation between the nasalance scores and different CRS severity classifications. The Kruskal-Wallis test was used to analyze the nasalance scores of the different CRS severity groups. A *p* value <0.05 was defined to be significant.

Results

Nasalance in patients with bilateral CRS

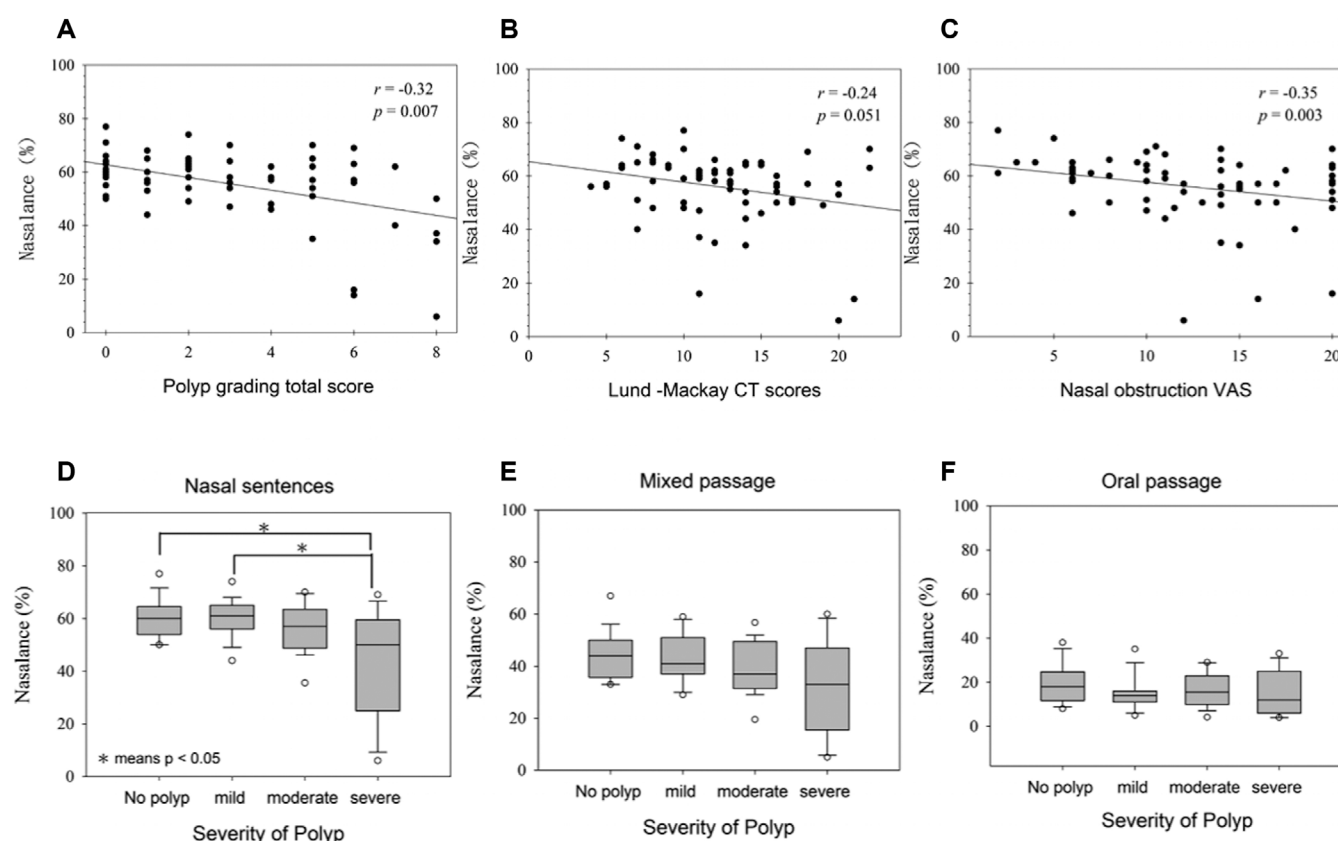
The nasalance scores for patients with CRS were 16.5% ± 8.5%, 40.1% ± 12.0%, and 55.8% ± 12.7% in the oral passage, mixed passage, and nasal sentences. The

TABLE 1. The correlation of polyp grading score, Lund-Mackay CT score, and NO-VAS, with nasalance scores in oral passage, mixed passage, and nasal sentences*

Parameter	Oral passage	Mixed passage	Nasal sentences
Polyp grading	$r = -0.154, p = 0.206$	$r = -0.261, p = 0.030$	$r = -0.32, p = 0.007$
Lund-Mackay CT score	$r = -1.07, p = 0.379$	$r = -0.200, p = 0.095$	$r = -0.024, p = 0.051$
NO-VAS	$r = -0.242, p = 0.048$	$r = -0.360, p = 0.003$	$r = -0.350, p = 0.004$

*Bold values are significant.

CT = computed tomography; NO-VAS = nasal obstruction visual analogue scale.

**FIGURE 1.** The correlation between nasalance scores of nasal sentences and polyp grading score (A), Lund-Mackay total score (B), and NO-VAS total score (C), and the correlation between polyp grading severity and nasalance scores on nasal sentences (D), oral passage (E), and mixed passage (F). NO-VAS = nasal obstruction visual analogue scale.

differences in nasalance scores of the 3 speech stimuli were statistically significant for pairwise comparisons: oral passage to nasal passage ($p < 0.001$), oral passage to nasal sentences ($p < 0.001$), and mixed passage to nasal sentences ($p < 0.001$).

Effect of CRS severity on nasalance scores

The correlation between the polyp grading scores and nasalance scores were statistically significant for nasal sentences ($p < 0.001$) and the mixed passage ($p = 0.03$) but was nonsignificant for the oral passage ($p = 0.206$). The NO-VAS result showed a significant correlation with the oral passage ($p = 0.048$), mixed passage ($p = 0.028$),

and nasal sentences ($p = 0.004$). The correlation with the LMCTS was marginally significant for nasal sentences ($p = 0.051$), otherwise nonsignificant (Table 1).

The Spearman linear regression model showed significant negative correlation between the nasalance scores of nasal sentences and polyp grading ($p = 0.01$), and NO-VAS scores ($p = 0.02$), whereas no such relationship was observed with the LMCTS (Supporting Fig. 1A–C). Significant differences were observed between the severe and mild polyp groups ($p = 0.008$), and between the severe and nonpolyp groups ($p = .009$) for nasal sentences, but those between the mixed and oral passages were nonsignificant (Supporting Fig. 1D,E).

Discussion

Influence of CRS on nasalance scores

The correlation of the severity on polyp grading and NO-VAS with the nasalance scores were significant, especially with nasal sentences; whereas the correlation of LMCTS was marginally significant with nasal sentences, otherwise nonsignificant (Table 1). The Spearman linear regression model also demonstrated significant findings with polyp grading and NO-VAS, whereas it was nonsignificant with LMCTS (Fig. 1A–C). These results indicated that the patency of nostrils might have greater influence on the nasal resonance than those of the sinuses. In addition, LMCTS ranked all sinuses equally regardless of the anatomical structures, which may not be able to reflect their variable contributions to nasal resonance in reality.

Therefore, we used polyp grading scores and nasal sentences to investigate the changes in the nasalance scores in different CRS severity groups. There is a significantly lower nasalance score in the severe polyp group compared to the mild and no-polyp groups (Supporting Fig. 1D,E). Although

nonsignificant, there is still a trend of lower nasalance scores in severe polyp groups on mixed and oral passages.

Park et al.¹⁰ reported a nonsignificant correlation between the polyp-grading scores and nasalance scores. We attributed this observation to the distribution of disease severity in their study population. Because most cases of CRS in their studies were graded as mild to moderate in severity, the correlation may not have been clear.

The limitations of this study was that it did not include evaluation of nasal volume, nasal resistance, and perceptual auditory evaluation of voice, which would help to compare the subjective and objective changes of nasalance in patients with CRS.

Conclusion

In conclusion, the patients with severe CRS had significant lower nasalance scores. In addition, the higher polyp grading scores and NO-VAS scores were associated with lower nasalance values, which were especially remarkable with nasal sentences. ❧

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