ORIGINAL ARTICLE

Validation of a Visual Analog Scale for Loss of Smell as a Quick Test in Chronic Rhinosinusitis With Nasal Polyps

Alobid I[1,2,3]*, Calvo-Henríquez C[4,5]*, Viveros-Díez P[6], López-Chacón M[1,2,3], Rojas-Lechuga MJ[2,3,7], Langdon C[1,2,3], Marin C[2,3], Mullol J[2,3,7]

[1]Skull Base Unit, ENT Department, Hospital Clínic Barcelona, IDIBAPS, Barcelona University, Barcelona, Catalonia, Spain
[2]INGENIO, IRCE, Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), Barcelona, Catalonia, Spain
[3]CIBER of Respiratory Diseases (CIBERES), Institute of Health Carlos III, Spain
[4]Rhinology Unit, ENT Department, Hospital Complex of Santiago de Compostela, Santiago de Compostela, Spain
[5]Young-Otolaryngologists of the International Federations of Oto-rhino-laryngological Societies (YO-IFOS) Study Group
[6]ENT department, University Hospital of Valladolid, Valladolid, Spain
[7]Rhinology Unit and Smell Clinic, ENT Department, Hospital Clínic Barcelona, IDIBAPS, Barcelona, Catalonia, Spain
*These authors share first-author responsibilities.

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Abstract

Background and Objective: The diagnostic criteria of chronic rhinosinusitis with nasal polyps (CRSwNP) include olfactory dysfunction. We hypothesize that patients with CRSwNP can self-assess their sense of smell better using a visual analog scale (VAS) than using smell tests.
Methods: A controlled cross-sectional study was performed. Adults diagnosed with severe CRSwNP waiting for endoscopic sinus surgery were included. A cohort of healthy controls was also studied. All participants completed the Barcelona Smell Test 24 (BAST-24), the 22-item Sinonasal Outcomes Test 22 (SNOT-22), and a VAS for loss of smell. Patients with CRSwNP underwent blood testing (eosinophil count, total serum IgE), computed tomography (Lund-Mackay Score), and nasal endoscopy.
Results: The study population comprised 138 patients with severe CRSwNP and 40 controls. The BAST-24 identification score was strongly correlated with the VAS score in the CRSwNP group (ρ=–0.79, P<.001) but not in the control group (ρ=–0.14; P=.39), this difference between groups being statistically significant (P<.001). A significant correlation was found between SNOT-22 item 21 (loss of smell) and BAST-24 identification (ρ=–0.65, P<.001), this difference being statistically significant (Z=–2.43; P=.015). The area under the receiver operating curve was 0.85, with 72.5% sensitivity and 93.1% specificity.
Conclusion: This study demonstrates a potential role of the VAS score for the screening of olfactory dysfunction in severe CRSwNP in daily clinical practice.

Key words: Polyposis. CRSwNP. Rhinosinusitis. BAST-24. Smell.

Resumen

Introducción y Objetivo: Los criterios diagnósticos de la rinusitis crónica con pólipos nasales (CRSwNP, por sus siglas en inglés) incluyen, entre otros, la disfunción olfatoria (OD). Nuestra hipótesis es que los pacientes que padecen CRSwNP son buenos para autoevaluar su sentido del olfato a través de una escala analógica visual (VAS) en comparación con pruebas de olfato.
Métodos: Se llevó a cabo un estudio transversal controlado. Se incluyeron adultos diagnosticados con CRSwNP grave que esperaban una cirugía endoscópica de senos nasales. También se estudió una cohorte de controles sanos. Todos los participantes realizaron la prueba de olfato de Barcelona (BAST-24), el cuestionario de resultados sinonasales 22 (SNOT-22) y la VAS para la pérdida del olfato. Los pacientes con CRSwNP se sometieron a análisis de sangre (recuento de eosinófilos, IgE sérica total), tomografía computarizada (puntuación de Lund-Mackay) y endoscopia nasal.
Resultados: Se incluyeron 138 pacientes con CRSwNP grave y 40 sujetos de control. La puntuación de identificación de BAST-24 se correlacionó fuertemente con la puntuación de VAS en el grupo CRSwNP (rho=-0,79, p<0,001), pero no en el grupo de control (rho=-0,14; p=0,39), siendo esta diferencia entre grupos estadísticamente significativa (p<0,001). También se encontró una correlación significativa del ítem 21 de SNOT-22 (pérdida del olfato) con la identificación de BAST-24 (rho=-0,65, p<0,001), siendo esta diferencia estadísticamente significativa (Z=-2,43; p=0,015). En la curva ROC, el área bajo la curva (AUC) fue 0,85 con una sensibilidad del 72,5% y una especificidad del 93,1%.
Conclusión: Este estudio demuestra un posible papel de la puntuación de VAS para la detección de OD en CRSwNP grave en la práctica clínica diaria.

Palabras clave: Pólipos. CRSwNP. Rinusitis. BAST-24. Olfato.

Summary box

- **What do we know about this topic?**
  Chronic rhinosinusitis is usually accompanied by olfactory dysfunction. Use of a visual analog scale for diagnosis is controversial. No validation study has been performed to date exclusively in this cohort of patients.
- **How does this study impact our current understanding and/or clinical management of this topic?**
  This study demonstrated a high correlation between the visual analog scale and instrumental evaluation of smell in patients with severe chronic rhinosinusitis with nasal polyps (ρ=0.79), but not in healthy controls (ρ=0.14).

Introduction

Chronic rhinosinusitis with nasal polyps (CRSwNP) is a highly prevalent disease that affects 0.5%-5% of the population [1]. The diagnostic criteria of CRSwNP and CRS without nasal polyps include olfactory dysfunction (OD) [2,3].

OD is also highly prevalent, affecting approximately 5% of the general population [4]. However, this prevalence is greatly increased in patients with CRSwNP [5], where a 60%-80% prevalence of loss of smell has been reported [6].

According to the EPOS guidelines [2], OD should be instrumentally assessed through validated smell tests (eg, the University of Pennsylvania Smell Identification Test [UPSIT], Sniffin' Sticks, or the Barcelona Smell Test 24 [BAST-24]). However, other guidelines such as POLINA 2.0 [7] also suggest using a visual analog scale (VAS). As smell tests can be time consuming, an alternative tool to quickly assess which patients require a full olfactory work-up is necessary. There are 2 main options, either a short instrumental smell test or a subjective self-report.

Previous experiences have shown a poor correlation between subjective and instrumental assessment of OD [8]. However, none of these reports were conducted exclusively in patients with CRSwNP. Such an approach is of the utmost importance, as affected patients have a fluctuating sense of smell [9]. It has also been reported that patients who are more aware of their sense of smell obtain better correlations between the subjective and instrumental assessment [8]. In fact, the frequency of unawareness of OD was only 16% in CRS [10], much lower than the 30% reported by Lötsch and Hummel [8] in a nonselected population, and 77% in elderly individuals. [11]

We hypothesize that patients with CRSwNP are better at self-assessing their sense of smell by using a VAS than by using an instrumental smell test (gold standard).

Methods

Study Population

We performed a controlled cross-sectional study. Data were recorded from 2014 to 2017.

To be included, patients had to be adults (≥18 years) recruited from the rhinology unit of 2 tertiary referral university hospitals (Hospital Clinic, Barcelona and University Hospital of Valladolid). All participants were diagnosed with severe CRSwNP according to the EPOS 2012 criteria [12] and were placed on the waiting list for endoscopic sinus surgery (ESS).

There were no modifications in asthma treatment, and patients with sinonasal neoplasms, cystic fibrosis, ciliary dysfunction, or CRS without nasal polyposis were excluded from the study.

Healthy controls were selected from the Skull Base Unit of Hospital Clinic, Barcelona. The control group included patients (≥18 years) with benign diseases of the skull base and no sinonasal conditions or smell dysfunction who underwent transsphenoidal endoscopic surgery.

The study was performed in accordance with the ethical standards established in the Declaration of Helsinki, and all patients signed the informed consent document. The study protocol was approved by the Research and Ethics Committee of Hospital Clínic, Barcelona (HCB/2015/1021).

Outcomes

The demographic characteristics recorded included sex and age. We also recorded a series of clinical data, namely, asthma, NSAID-exacerbated respiratory disease (N-ERD), olfaction assessed through a VAS and BAST-24, the nasal polyp score (NPS), the 22-item Sinonasal Outcomes Test (SNOT-22), allergy, blood eosinophil count (BEC), and total IgE (IU/mL). For the statistical analysis, age was categorized into 4 groups (18-30, 31-50, 51-70, and 71-90 years).

BAST-24 consists of 24 odors located on a solid base in sealed numbered boxes [13]. The 3 results of this test are detection (the individual detects an odor or not), memory (spontaneous recognition), and identification (the individual correctly identifies the odor among 4 possible options). In this study, the cut-off value for normosmia or hyposmia was defined according to published normative data for different age subgroups [13]. In healthy individuals, detection has a score of 99%, memory 54.6%, and forced choice identification 74.2% [13]. The BAST-24 was performed the week before ESS in outpatient clinics.

ENT Examination

– Nasal endoscopy. Participants were examined in the outpatient clinics of the rhinology units the week before ESS. All participants underwent nasal endoscopy, which

was performed by a different examiner from the one who performed the smell test.
- Meltzer clinical score. Nasal polyp size was classified using the Meltzer clinical score [14], which is graded on a scale of 0 to 4 (0, no polyps; 1, polyps confined to the middle meatus; 2, multiple polyps occupying the middle meatus; 3, polyps that extend beyond the middle meatus; 4, polyps that completely obstruct the nasal cavity).
- Loss of smell VAS. Patients were asked to rate their OD from 0 mm (no impairment) to 100 mm (complete loss of smell). Olfaction was rated before the BAST-24.
- SNOT-22. SNOT-22 is a validated questionnaire designed to assess quality of life in patients with sinonasal symptoms [15]. The validated Spanish version of the questionnaire was used [16]. It was completed by patients before the BAST-24. The total score ranges from 0 to 110. Item 21 (loss of smell/taste) was also used to assess loss of smell (score 0-5).
- Computed tomography (CT) scan (Lund-Mackay score). A sinonasal CT scan was performed in both cases and controls (2-mm thickness, square pixels).
  The extent of disease was scored using the Lund-Mackay score [17] by 2 examiners who were blinded to the results of the BAST-24. The Lund-Mackay score assesses each nasal sinus separately and the ostiomeatal complex. The total score ranges from 0 to 24.

Statistical Analysis

All quantitative variables were tested for normality using the Shapiro-Wilk test. Quantitative variables and dichotomous variables were compared using the *t* test when the distribution was normal and the Wilcoxon rank sum test when it was not. The relationship between qualitative variables was studied using the χ^2 test. The correlation between quantitative variables was assessed using the Spearman correlation coefficient. The correlation coefficients were compared using the CORTESTI package for STATA.

Test performance was assessed based on sensitivity, specificity, the positive and negative predictive values, and the Youden index. A receiver operating characteristic (ROC) curve was calculated for the VAS score. All statistical testing was 2-tailed. The α was set to 0.05 for significance. All statistical analyses were performed using STATA software v.16.1 (StataCorp).

Results

Demographic Characteristics

The study population is described in Table 1. A total of 178 participants were included (138 CRSwNP; 40 controls). The mean age was 52.3 years, and 62.9% were males. CRSwNP patients were slightly older than controls. Regarding comorbid conditions in the CRSwNP group, 53.6% had concomitant asthma, 25.4% N-ERD, and 48.6% atopy (based on symptoms and skin prick test results). None of the quantitative variables followed a normal distribution.

Table 1. Characteristics of the Study Population.[a]

	CRSwNP (n=138)	Healthy controls (n=40)	*P* value
Age, y	53.8 (13.1)	47.1 (13.2)	.005
Male sex, No. (%)	86 (62.3)	26 (65.0)	.757
Atopy, No. (%)	67 (48.6)	0	<.001
N-ERD, No. (%)	35 (25.4)	0	<.001
Asthma, No. (%)	74 (53.6)	3 (7.5)	<.001
SNOT-22 (0-110),	39.4 (2.1)	27.3 (3.7)	.006
SNOT-22 item 21 (0-5)	3.4 (0.2)	0.7 (0.2)	<.001
BAST-24 detection	57.4 (3.6)	99.9 (0.1)	<.001
BAST-24 identification	37.9 (3.0)	64.8 (2.4)	<.001
BAST-24 memory	42.1 (3.6)	74.4 (3.5)	<.001
Nasal polyp score	4.6 (1.5)	NA	NA
Total IgE, IU/mL	235.1 (387.4)	NR	NA
Lund-McKay Score (0-24)	15.9 (0.5)	0.5 (0.1)	<.001
Blood eosinophils, %	4.2 (0.4)	1.3 (0.2)	<.001
Blood eosinophils/μL	574.3 (37.8)	150.3 (20.4)	<.001

Abbreviations: BAST-24, Barcelona Smell Test 24; CRSwNP, chronic rhinosinusitis with nasal polyposis; N-ERD, NSAID-exacerbated respiratory disease; NA, not applicable; NR, not reported; NSAID, nonsteroidal anti-inflammatory drug; SNOT-22, 22-item Sinonasal Outcomes Test 22.
[a]Values are shown as mean (SD) unless otherwise indicated.

Olfactory Data and Correlations

BAST-24 identification was strongly correlated with the VAS in the CRSwNP group (ρ=–0.79, *P*<.001) (Figure 1) but not in the control group (ρ=–0.14; *P*=.39); the difference between both correlations was statistically significant (z=5.01; *P*<.001). Similar data were found for detection (ρ=–0.70, *P*<.001; ρ=0.09, *P*=.582), and, again, the difference was statistically significant (z=4.19, *P*<.001). This was also true for memory (ρ=–0.44, *P*<.001; ρ=–0.05, *P*=0.776), with a significant difference between the groups (z=2.28, *P*<.023).

The same comparisons were assessed with SNOT-22 question 21 (loss of smell/taste). There was also a significant—albeit lower—correlation with identification (ρ=–0.65, *P*<.001), detection (ρ=–0.39, *P*<.001), and memory (ρ=–0.55, *P*<.001). The difference between the correlation for question 21 and for the VAS score was statistically significant (z=–2.43; *P*=.015).

A subgroup analysis of nasal polyp size in the CRSwNP group revealed a statistically significant difference (χ^2=17.43, *P*<.001), with worse results in BAST-24 identification as nasal polyp size increased. There was no difference in the correlation score between groups according to nasal polyp size.

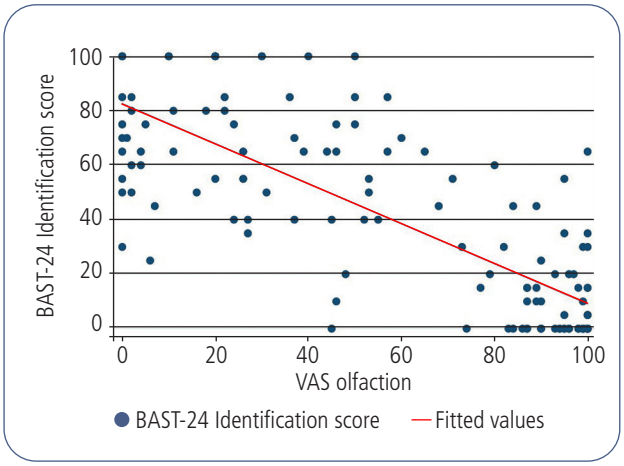

Figure 1. Dot diagram and linear regression for olfaction VAS score and BAST-24 identification score. BAST-24 indicates Barcelona Smell Test 24; VAS, visual analog scale.

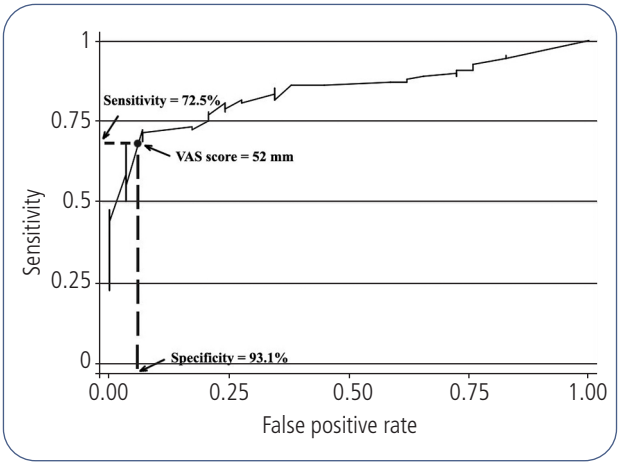

Figure 2. Receiver operating characteristic curve for olfaction VAS score in patients with chronic rhinosinusitis with nasal polyposis. VAS indicates visual analog scale.

A subgroup analysis according to age subgroups in the CRSwNP group failed to demonstrate statistically significant differences in BAST-24 smell identification. No difference in the correlation score was recorded between the groups.

When VAS olfactory loss was categorized according to severity as 0-30, >30-70, and >70-100, a significant correlation was only demonstrated in the severe cases (VAS >70-100; ρ=–0.35; *P*=.002). This difference in correlation between the groups was statistically significant (z=2.59; *P*=.009).

Subgroup analyses of these correlations between self-assessment of OD and BAST-24 identification were also conducted for asthma, N-ERD, and atopy. The only significant difference was observed for asthma (z=–2.09, *P*=.037), with a higher correlation in nonasthmatic patients (ρ=–0.86 vs 0.73).

In CRSwNP, BAST-24 identification was also moderately correlated with BEC (ρ=–0.29, *P*<.001) and the Lund-Mackay score (ρ=0.37, *P*<.001). There was no correlation with total IgE.

Table 2. Contingency Table for CRSwNP Patients According to the VAS for Loss of Smell and BAST-24.

	BAST-24 identification +	BAST-24 identification –	
VAS +	79	2	PPV, 97.5%; 95%CI (91.4-99.7)
VAS +	30	27	NPV, 47.4%; 95%CI (34-61)
	Se, 72.5%; 95%CI (63.1-80.6)	Sp, 93.1%; 95%CI (77.2-99.2)	

Abbreviations: BAST-24, Barcelona Smell Test 24; CRSwNP, chronic rhinosinusitis with nasal polyposis; NPV, negative predictive value; PPV, positive predictive value; Se, Sensitivity; Sp, specificity; VAS, visual analog scale.

SNOT-22 Data and Correlations

In CRSwNP, a moderate correlation was found between SNOT-22 and BAST-24 detection (ρ=–0.39, *P*<.001), memory/recognition (ρ=–0.44, *P*<.001), and identification (ρ=–0.51, *P*<.001). There was no correlation between those outcomes in the control group (ρ=0.11, 0.18, and –0.05, respectively).

A correlation was found between the SNOT-22 score and the NPS, with an increase in the SNOT-22 score as the size of the polyps increased (χ^2=28.01, *P*<.001), although there was no correlation with the Lund-Mackay score (*P*=.208).

ROC Curve

In the CRSwNP group, the BAST-24 identification score was categorized as positive or negative following the 75% cut-off value, ie, according to the normative data for patients aged between 50 and 60 years [13]. A ROC curve was plotted using this cut-off value (Figure 2). The mean area under the curve was 0.85 (0.03). The result with the highest number of correctly classified patients (77%) and the highest Youden index (0.66) was VAS 52 mm.

Contingency Table in CRSwNP

A contingency table was constructed using a cut-off value of 75% for the BAST-24 forced-choice smell identification and 52 cm for the VAS score (Table 2). The positive likelihood ratio and the negative likelihood ratio were 10.51 and 0.30, respectively.

IgE and BEC Subgroup Analysis

BEC was categorized using a cut-off value of 250/µL (Table 3). There was a statistically significant difference in the Lund-Mackay score, loss of smell VAS, and BAST-24 identification, detection, and memory, with worse results for these patients at >250/µL. No differences were observed for SNOT-22 total score, SNOT-22 question 21 (although it almost reached significance), or the NPS.

Table 3. Subgroup Analysis of Olfactory Dysfunction (BAST-24 and VAS) According to the Presence of Type 2 Comorbidities in CRSwNP Patients.[a]

		BAST-24 detection (0-100%)	BAST-24 memory (0-100%)	BAST-24 identification (0-100%)	VAS loss of smell (0-100 mm)
CRSwNP	Asthma (n=74)	53.9 (43.1)	38.8 (37.3)	33.3 (33.3)	64.6 (37.1)
	No asthma (n=63)	61.7 (39.8)	45.9 (40.1)	43.3 (36.0)	56.8 (37.8)
		z=0.98 *P*=.328	z=0.98 *P*=.328	z=1.66 *P*=.096	z=–1.33 *P*=.182
CRSwNP	N-ERD (n=35)	32.9 (41.4)	23.6 (33.1)	20.7 (30.2)	82.1 (28.3)
	No N-ERD (n=103)	65.5 (38.6)	47.9 (38.6)	43.6 (34.5)	53.9 (37.6)
		z=3.93 *P*<.001	z=3.15 *P*<.001	z=3.4 *P*<.001	z=–4.03 *P*<.001
CRSwNP	Atopy (n=67)	63.3 (40.7)	49.0 (36.8)	38.8 (32.0)	58.2 (39.0)
	No atopy (n=71)	52.0 (42.0)	35.3 (39.5)	37.1 (37.4)	63.8 (36.1)
		z=–1.78 *P*=.076	z=–1.78 *P*=.076	z=–0.550 *P*=.582	z=0.60 *P*=.551

Abbreviations: BAST-24, Barcelona Smell Test 24 odors; CRSwNP, chronic rhinosinusitis with nasal polyps; N-ERD, NSAID-exacerbated respiratory disease; NSAID, nonsteroidal anti-inflammatory drug; VAS, visual analog scale.
[a]Data are presented as mean (SD).

Table 4. Subgroup Analysis According to Blood Eosinophil Count in CRSwNP Patients.[a]

	BEC <250/µL (n=22)	BEC ≥250/µL (n=115)	Statistical analysis
LMS (0-14)	13.5 (5.5)	16.4 (5.8)	z=–2.26, P=.024*
NPS (0-8)	4.5 (1.6)	4.6 (1.6)	z=–0.75, P=.457
Loss of smell VAS (0-100mm)	45.6 (34.9)	64.0 (37.4)	z=–2.22, P=.027*
BAST-24 detection (0-100%)	80.0 (30.1)	53.4 (42.0)	z=2.47, P=.014*
BAST-24 memory (0-100%)	63.1 (32.24)	38.8 (38.6)	z=2.19, P=.028*
BAST-24 identification (0-100%)	56.7 (32.5)	34.5 (34.2)	z=2.78, P=.005*
SNOT-22 score (0-110)	39.2 (26.4)	39.4 (24.4)	z=–0.16, P=.870
SNOT-22 item 21 (0-5)	2.6 (1.9)	3.5 (1.7)	z=–1.88, P=.059

Abbreviations: BAST-24, Barcelona Smell Test 24 odors; BEC, blood eosinophil count; CRSwNP, chronic rhinosinusitis with nasal polyps; LMS, Lund-Mackay score; NPS, nasal polyp size; SNOT-22, 22-item Sinonasal Outcomes Test 22; VAS, visual analog scale.
[a]Data are presented as mean (SD).

A significant difference in NPS was demonstrated when IgE was categorized using 100 IU/mL as a cut-off value, being higher in those with higher IgE values (z=–2.47, *P*=.014). A significant difference was also recorded for the SNOT-22 total score, being higher for those with higher IgE values (43.6 vs 30.7) (z=–2.59; *P*=.009). No differences were found for the Lund-Mackay score, loss of smell VAS, or BAST-24 smell identification and detection.

Type 2 Comorbidity Subgroup Analysis

The patient cohort was categorized according to the presence/absence of asthma, N-ERD, and atopy co-occurring with CRSwNP (Table 4). Patients with N-ERD had worse BAST-24 identification, detection, and memory (*P*<.001) and a worse loss of smell measured by VAS (*P*<.001).

Discussion

We report 3 main findings. First, there is a strong correlation between subjective assessment (VAS) and instrumental assessment (BAST-24) of smell in CRSwNP patients. Second, the best cut-off value for the VAS score in this study is 52 mm. Third, this correlation is influenced by other factors, such as severity of OD and asthma.

The main finding of our study is the strong correlation between the VAS score and the smell test in CRSwNP patients

(ρ=–0.79). Therefore, we hypothesize that the VAS score could serve as a screening test in severe CRSwNP. Although OD has long been recognized as a prognostic factor in CRSwNP, it has recently gained notoriety, since clinical guidelines such as EUFOREA [18] and EPOS [2] include OD as a criterion for the indication of and response to treatment with monoclonal antibodies. We suggest that an olfactory VAS could serve as a method for monitoring CRSwNP patients, even though results should always be confirmed using a validated instrumental olfactory test. The results presented here should be interpreted with caution, as data were collected in a highly selected cohort (severe CRSwNP patients undergoing ESS). To date, no study comparing the correlation between VAS and the smell test has been performed exclusively on CRSwNP patients. All previous studies were performed on patients with OD or healthy volunteers. No correlation has been demonstrated in healthy volunteers [19].

The evidence presented here suggests that the ability of CRSwNP patients to self-rate their OD is better than that of other patients with OD or even healthy people (control group). Previously published studies have reported worse correlations [20-23], ranging from 0.29 [24] to 0.64 [22]. This aspect was recently studied in COVID-19 patients, where the correlation found was a moderate 0.51 [25] (compared with 0.79 in our study).

We hypothesize that patients with chronic nasal inflammation are more prone to variations in their sense of smell and, consequently, more aware of it. Landis et al [23] demonstrated that patients who are more aware of their sense of smell are better at self-assessing their olfactory ability. This observation is reinforced by our results, since the correlation was weaker between SNOT-22 item 21 and BAST-24 than for loss of smell VAS. Despite being the same cohort replying to the same question (self-rating loss of smell), patients performed better when they focused exclusively on assessing their sense of smell and not as part of a broader symptom assessment.

The second main finding of this study is the cut-off value for the VAS. In our sample, the best value was 52 mm. This result is similar to that reported by Takebayashi et al (47%) [26] but notably higher than that reported by Zou et al (6.7%) [24]. These studies differed in terms of both the gold standard test (BAST-24 vs T&T and Sniffin Sticks) and the study population (CRSwNP vs nonselected patients with olfactory disorders).

Sensitivity and specificity can be calculated using a cut-off value of 52 mm. This is of the utmost importance, as a correlation analysis is not the best way to evaluate the performance of a screening test. As the objective of a screening test is to identify as many positive results as possible, sensitivity and specificity are better measurements of its performance. Unfortunately, there is scarce information with which to compare our results, as only a few studies have reported sensitivity and specificity [8,26]. The largest study assessed 6050 individuals and reported a sensitivity of 71% and a specificity of 87% for diagnosis of OD based on the VAS score [8]. Our results were slightly better, with similar sensitivity (72%) but increased specificity (93%) using BAST- 24 identification as the gold standard.

Finally, the third main result of this study is that the correlation observed may be influenced by other factors such as asthma or the severity of OD. Interestingly, in our sample, the correlation between VAS and BAST-24 was independent of age. This similar correlation according to age subgroups was surprising, as the rate of false diagnosis increases with age [8]. However, in this study, age was not related to a decrease in the correlation.

OD in CRSwNP probably occurs through 2 different but combined mechanisms. First, mechanical obstruction of the olfactory cleft can impair airflow in the region of the olfactory cleft [27]. This hypothesis is supported by a previous meta-analysis, which demonstrated a positive effect of surgery [28]. Our study also supports this hypothesis, as we found a significant relationship between the NPS and smell test outcomes. The second mechanism is inflammatory, as inflammation in the olfactory cleft can impair olfaction. Another meta-analysis demonstrated a positive effect for oral and topical corticosteroids on olfaction [29]. In our study, we also found a significant correlation between eosinophilia and the BAST-24 score. This could reflect the inflammatory process that supports this second hypothesis [6].

Our study is subject to a series of limitations. First, this was a tracing study, performed only in CRSwNP patients undergoing ESS. These patients comprise a highly selected cohort and may not reflect all individuals with CRSwNP. A future study should be performed on a day-to-day basis, assessing the whole spectrum of patients with CRSwNP.

Second, olfactory thresholds were not studied, since BAST-24 does not include a threshold smell test. This may not be a problem, as a meta-analysis revealed significant differences for the identification test but not for the threshold of the Sniffing Sticks test in CRS patients after surgery [28], suggesting that smell identification may be better than smell threshold when analyzing OD in patients with CRS. However, future studies should include a threshold test to assess this important question.

Third, as the study patients had severe CRSwNP, they may have been previously asked about or undergone instrumental assessment of their sense of smell. Given the retrospective nature of the study, this variable was assessed and could introduce an information bias.

Fourth, Landis et al [23] reported a relationship between nasal airflow and sense of smell. As nasal airflow is decreased in patients with CRSwNP, it would have been interesting to perform a subgroup analysis according to nasal airflow. Again, this is a retrospective study, and the patients included did not undergo rhinomanometry.

In conclusion, this tracing study validated the VAS score as a tool for screening for olfactory loss in CRSwNP undergoing ESS. Future studies will broaden the spectrum of patients assessed. If future large-scale studies confirm the significant association between VAS scores and smell tests in patients with CRSwNP, then this score could be implemented in daily practice and further confirmed by smell tests.

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Conflicts of Interest

J. Mullol is a member of national and international advisory boards and has received speaker fees or funding for clinical trials and research projects from Allakos, AstraZeneca, Genentech, GSK, Glenmark, Menarini, Mitsubishi-Tanabe, MSD, VIATRIS/MEDA Pharma, Novartis, Proctor & Gamble, Regeneron Pharmaceuticals, Inc., Sanofi-Genzyme, UCB Pharma, and Uriach/Noucor Group. I. Alobid has received honoraria for consultancy and conferences from Viatris, Roche, Sanofi, GSK, MSD, Menarini, Salvat, and Novartis. C. Calvo has received honoraria for conferences from GSK, Cinfa, and Viatris and consultancy honoraria from Forwardontics. The remaining authors declare that they have no conflicts of interest.

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Isam Alobid

Skull Base Unit
ENT Department, Hospital Clinic
Barcelona University
Spain
E-mail: isamalobid@gmail.com
Joaquim Mullol
E-mail: jmullol@clinic.cat