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## ORIGINAL STUDY

# Olfactory Function as a Postoperative Parameter for Success of Functional Endoscopic Sinus Surgery in Chronic Rhinosinusitis With Nasal Polyps

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### Abstract

**Background:** Allergic nasal polyps associated with chronic rhinosinusitis always leads to disturbed sense of smell and impaired life quality. After failure of medical treatment in the form of anti-histaminic and local steroids, we usually proceed to functional endoscopic sinus surgery (FESS) to improve life quality.

**Aim:** The aim of this study is to evaluate the results of FESS in CRSwNP regarding olfactory function and life quality as a postoperative indicators of success of surgery.

**Methods:** Total 48 patients were comprised in this work. All patients were subjected to routine nasal examination, nasal endoscopy and CT scans paranasal sinuses axial and coronal cuts before surgery and 3 months after operation. We used Sniffin' sticks to assess psychophysical olfactory function.

**Results:** Disturbance of sense of smell was proved by psychophysical tests before surgery. Olfactory test results were matched with endoscopic examination and radiological investigations before surgery. Three months after FESS olfactory function was markedly improved and with much more better life quality. The success was dependant upon the degree of olfactory dysfunction before surgery. It was recorded that patients with hyposmia or complete anosmia were much more improved than patients with normal smell before surgery.

**Conclusion:** This study proved that all cases with chronic rhinosinusitis associated with nasal polyposis showed marked improvement of smell and life quality after endoscopic surgery. However, the evaluation of smell disturbance and psychosocial condition before FESS may help to detect the results of surgery regarding olfaction and life quality.

**Keywords:** Chronic rhinosinusitis, Nasal polyps, Olfaction, FESS

## 1. Introduction

Chronic rhinosinusitis (CRS) may be associated with nasal polyps, and it is a well-known medical problem. The estimated prevalence between populations is between 7 and 27% [1]. The main symptoms include nasal obstruction, nasal discharge, headache, and olfactory dysfunction. Smell disorders occur in about 78% of patients [2,3]. On the contrary, CRS is the commonest cause of olfactory disturbance [4]. There are two explanations for olfactory disturbance. First, excessive secretions and mucosal edema of the nose, which act as a barrier for the olfactory area and prevents the

olfactory molecules from reaching the olfactory area [5,6].

Second, inflammatory mediators invade the olfactory neuroepithelium. This inflammation leads to destruction of the olfactory epithelium and loss of sense of smell [6–8].

The main line of treatment of CRS is antihistaminic, nasal wash, and local steroids, and in many patients, clinical cure regarding nasal obstruction and sense of smell might occur [9]. After failure of medical treatment, we proceed to functional endoscopic sinus surgery (FESS). Surgical interference is mainly indicated in patients with CRS with nasal polyps (CRSwNP), with marked improvement of all

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symptoms after surgery including life quality [10]. Regarding sense of smell, marked progress is seen after surgery in both subjective and psychophysical assessments [11].

The aim of this study was to evaluate the results of FESS in CRSwNP regarding olfactory function and life quality as a postoperative indicator of success of surgery. Finally, we investigate the relation between both radiological findings by computed tomography (CT) scan and endoscopic examination and olfactory disturbance.

## 2. Patients and methods

This study included 48 patients with CRSwNP, between June 2019 and October 2021. All these patients were diagnosed by nasal endoscopy and confirmed by CT scans at Otorhinolaryngology Department of October 6 University Hospitals. All patients were subjected to basic surgical technique of FESS including middle meatal antrostomy and ethmoidectomy by the same surgeon. History was taken from all patients regarding aspirin sensitivity and asthma. All the patients were examined by endoscopy and psychophysical olfactory testing a few days before surgery. All patients were prepared for evaluation of olfaction by a self-assessment of sense of smell by Sing-Nasal Outcome (SNOT-20) [12]. CT scans of paranasal sinuses axial and coronal cuts without contrast were performed for all patients for confirmation of olfactory area opacification, in addition to routine preoperative laboratory investigations for eosinophilia.

Three months after FESS, all patients were re-examined by nasal endoscopy, questionnaires, and CT scans exactly like preoperative assessment.

Psychosocial testing was done a few days before FESS and postoperatively by Sniffin' sticks smell test [13]. The aim of this test was to evaluate phenyl ethyl alcohol odor threshold, odor identification, and odor discrimination. The recorded scores for threshold (T, maximum 16 points), identification (I, maximum 16 points), and discrimination (D, maximum 16 points) and summation of these scores for TDI score (maximum 48 points) were analyzed. The score used for anosmia is less than 16, hyposmia is 16–30, and normosmia is more than 30 [14].

Regarding endoscopic examination of patients before surgery and 3 months after FESS, Lildholdt score and Lund–Kennedy score were used. The size of polyps (0: no polyps; 1 = polyps not reaching the inferior turbinate; 2 = polyps not reaching the lower edge of the inferior turbinate; and 3 = polyps reaching below the lower edge of the inferior turbinate) was recorded for each side alone, and the

total score is the Lildholdt score [15]. The presence of nasal polyps, discharge, edema, and crusting was recorded between 0 and 2 for each side, and scores were evaluated as Lund–Kennedy score [16].

CT scans of paranasal sinuses were performed before surgery, and the Lund–Mackay scoring system was used and the total opacification of the olfactory cleft (TOCS). Each ipsilateral sinuses (anterior and posterior ethmoid cells separately) and osteomeatal complex has been recorded (0, no opacification; 1, partial opacification; or 2, total opacification). The total score (maximum 24) is the summation of scores [17].

The assessment of quality of life was evaluated by specific questionnaire SNOT-20 which consists of 20 well-designed questions. The aim of these questions is to identify the sinonasal symptoms and to assess the results of surgical treatment of CRS [18].

Written informed consents were taken from all patients included in the study, and the study was approved by Research Ethics Committee of October 6 University.

The statistical analysis was performed using SPSS, statistics software (version 26, IBM, Armonk, New York, USA). Graphs were illustrated using prism software (version 9, Graph Pad Software, San Diego, California, USA). Values are expressed as mean  $\pm$  SD, and *P* value less than 0.05 was considered statistically significant. Continuous data were tested for statistical significance using one-way analysis of variance. Pearson correlation was used to assess the correlation between the scores.

## 3. Results

This study comprised 48 patients with CRS and nasal polyps, aged  $36 \pm 10$  years. All patients were subjected to FESS, and follow-up evaluation of surgery for all patients after 3 months was recorded. The study included 48 patients, comprising 36 (75%) males and 12 (25%) females. The distribution of all patients and their medical conditions are shown in Table 1 and Figs. 1 and 2.

The olfactory function for all patients was evaluated by the visual analog score (VAS: 0, no olfactory function, and 10, very good olfactory function). The VAS before FESS was  $2.8 \pm 1.9$  and the psychophysical test of olfactory function showed a mean TDI of  $16.8 \pm 9.2$ . The patients in the study were classified into 26 (54%) anosmic and 16 (33%) hyposmic and six (13%) normosmic patients.

After FESS, the smell function markedly improved, and this was confirmed by both VAS and psychophysical testing. The subjective olfactory function was  $5.8 \pm 2.2$  and by Sniffin' sticks, TDI was

Table 1. Chronic rhinosinusitis-related diseases, olfactory tests, life quality questionnaire, and endoscopic and radiological scores of all patients and in three groups.

	All (N = 48)		Anosmic (N = 26)		Hyposmic (N = 16)		Normosmic (N = 6)	
Age (years)	36 ± 10		39 ± 11		40 ± 14		34 ± 16	
Male	75%		70%		71%		76%	
Aspirin sensitivity	8%		10%		5%		12%	
Asthma	24%		40%		16%		18%	
Eosinophilia	68%		85%		56%		60%	
	Before	After	Before	After	Before	After	Before	After
TDI	16.8 ± 9.2	21.6 ± 8.4	7.8 ± 2.1	17.6 ± 4.2	23.1 ± 6.2	25.2 ± 3.1	32.6 ± 2.7	30.1 ± 3.2
Threshold	1.8 ± 1.7	3.1 ± 2.1	0.3 ± 7.1	2.1 ± 3.2	2.8 ± 1.6	3.2 ± 1.6	5.4 ± 2.5	6.2 ± 3.2
Discrimination	7.2 ± 3.2	8.9 ± 1.2	3.9 ± 1.4	7.8 ± 2.1	9.9 ± 2.1	10.1 ± 2.3	14.6 ± 1.7	12.4 ± 2.1
Intensity	7.1 ± 3.6	10.1 ± 2.2	3.6 ± 1.6	8.2 ± 2.5	9.8 ± 3.1	10.6 ± 2.5	13.6 ± 2.2	13.2 ± 1.6
SNOT-20	40.1 ± 14.1	21.1 ± 12.4	45.2 ± 13.6	20.1 ± 11.6	36.1 ± 12.1	17.2 ± 13.4	26.1 ± 14.2	23.1 ± 13.6
Primary nasal symptoms	58.1 ± 16.1	28.2 ± 13.1	65.7 ± 14.6	31.4 ± 16.8	51.1 ± 16.8	21.1 ± 14.8	42.4 ± 14.2	28.2 ± 16.1
Secondary nasal symptoms	33.1 ± 16.1	18.1 ± 14.2	34.2 ± 14.6	20.1 ± 16.4	26.8 ± 16.2	12.9 ± 13.2	20.8 ± 16.3	15.2 ± 12.1
General life quality	34.2 ± 16.2	19.2 ± 16.3	38.2 ± 15.2	18.1 ± 18.7	31.9 ± 14.2	17.2 ± 15.2	25.2 ± 18.4	22.4 ± 17.5
CT scores	13.9 ± 5.9		18.4 ± 4.1		12.2 ± 5.8		6.4 ± 5.2	
Lund–Mackey score								
TOCS	8.9 ± 4.8		14.2 ± 2		6.2 ± 3.8		2.8 ± 2.2	
Nasal endoscopy	7.2 ± 4.8	5.1 ± 3.8	9.2 ± 5.8	6.1 ± 3.2	5.8 ± 2.2	4.7 ± 2.1	5.1 ± 2.1	36.±2.3
Lund–Kennedy score								
Lildholdt score	2.9 ± 1.2	0.4 ± 7	2.9 ± 1.2	0.9 ± 1.3	2.6 ± 1.1	0.6 ± 1.3	2.0 ± 1.2	0.3 ± 1.3

CT, computed tomography; SNOT-20, Sing-Nasal Outcome; TOCS, total opacification of the olfactory cleft.

21.6 ± 6.4. It was recorded that the minimal clinically important difference of 5.5 points was detected [19]. The smell function improved in 24 (50%) out of 48 patients, did not change in 22 (46%) patients, and decreased in two (4%) patients only. There was marked improvement of olfactory function after FESS, especially in anosmic (75%) compared with hyposmic (26%) patients. On the contrary, only one (6%) hyposmic patient and two (33%) normosmic patients recorded decrease in sense of smell after FESS (Fig. 3a and b).

For all patients before surgery and after FESS, subjective self-evaluation correlated positively with the results of the Sniffin' sticks test ( $r = 0.68$ ,  $P < 0.0001$ ).

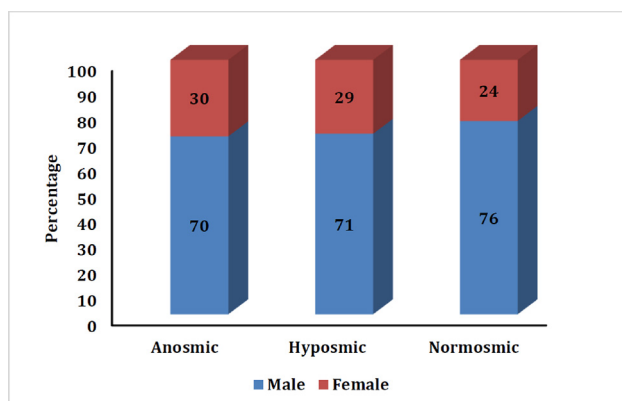


Fig. 1. Distribution of patients according to sense of smell.

Regarding CT paranasal sinuses before surgery the TOCS, a score for the opacification of the olfactory area was  $8.9 \pm 4.8$  for all patients. The score differed strongly among the three groups: normosmia ( $2.8 \pm 2.2$ ), hyposmia ( $6.2 \pm 3.8$ ), and anosmia ( $14.2 \pm 2.6$ ;  $P < 0.0001$ ). Accordingly, the TOCS had a very evident negative correlation with the preoperative TDI ( $r = -0.72$ ,  $P < 0.001$ ). The Lund–Mackay score for the opacification of paranasal sinuses in CT scans was  $13.9 \pm 5.9$ . Again, the score differed significantly among the three groups: normosmia,  $6.4 \pm 5.2$ ; hyposmia,  $12.2 \pm 5.8$ ; and anosmia,  $18.4 \pm 4.1$  ( $P < 0.001$ ). The Lund–Mackay score had a

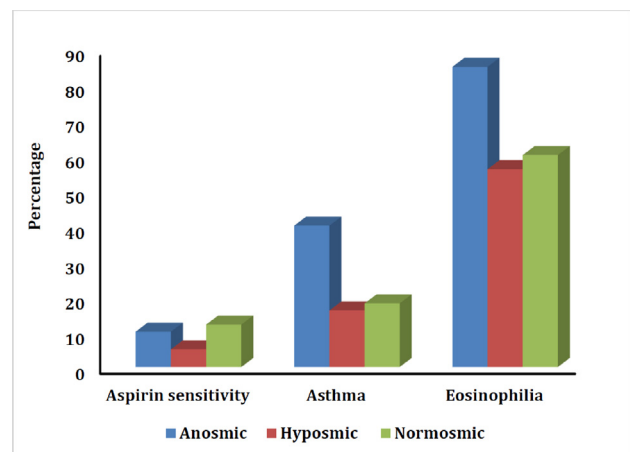


Fig. 2. Sense of smell in patients with aspirin sensitivity, asthma, and eosinophilia.

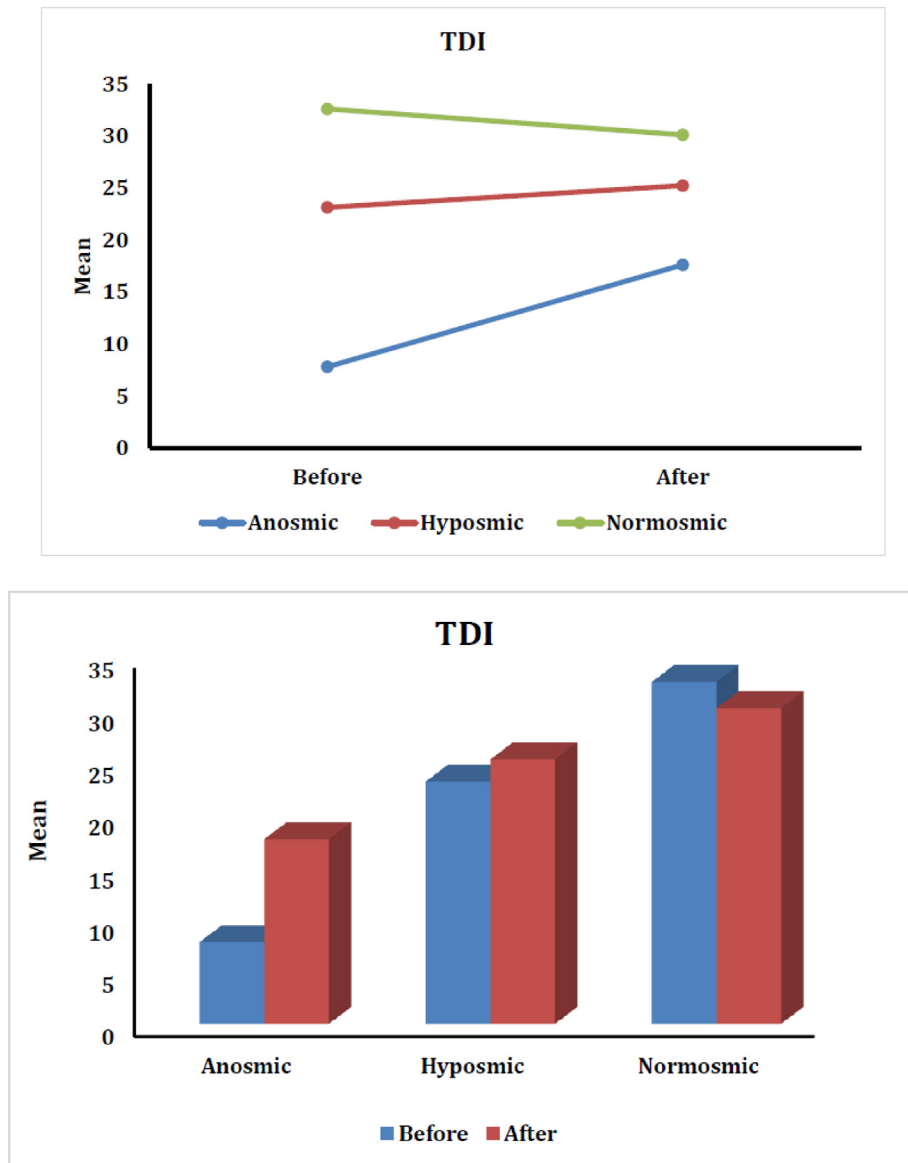


Fig. 3. (a, b) TDI scores of the three groups.

negative correlation with TDI before surgery ( $r = -0.57$ ,  $P < 0.001$ ) (Fig. 4).

Regarding nasal endoscopy, the Lund–Kennedy score was  $7.2 \pm 4.8$  before surgery and improved after FESS to  $5.1 \pm 3.8$ . The Lildholdt score before surgery was  $2.9 \pm 1.2$  and improved after FESS to  $0.4 \pm 0.7$ . In anosmic patients, both scores were higher ( $9.2 \pm 5.8$  and  $2.9 \pm 1.2$ , respectively) than in patients with hyposmia ( $5.8 \pm 2.2$  and  $2.6 \pm 1.1$ , respectively) and normosmia ( $5.1 \pm 2.1$  and  $2.1 \pm 1.2$ , respectively). Both before surgery and after FESS, these two scores correlated negatively with TDI ( $r = -0.47$ ,  $P < 0.001$ , and  $r = -0.48$ ,  $P < 0.001$ , respectively).

Regarding the quality of life, surgery improved SNOT-20 score, and there was a big difference

among the three groups. Patients with total loss of smell improved in 69% of patients and patients with hyposmia improved in 63% only.

#### 4. Discussion

This is a comparative study between sense of smell, nasal endoscopy, mucosal affection of the nose, and paranasal sinuses by CT scans and life quality before surgery and 3 months after FESS.

Generally, surgery improved olfaction in both self-evaluation and psychophysical tests, and this was proved in other studies [20,21]. Minimal clinically important difference psychophysically recorded 50% improvement in the sense of smell. It was

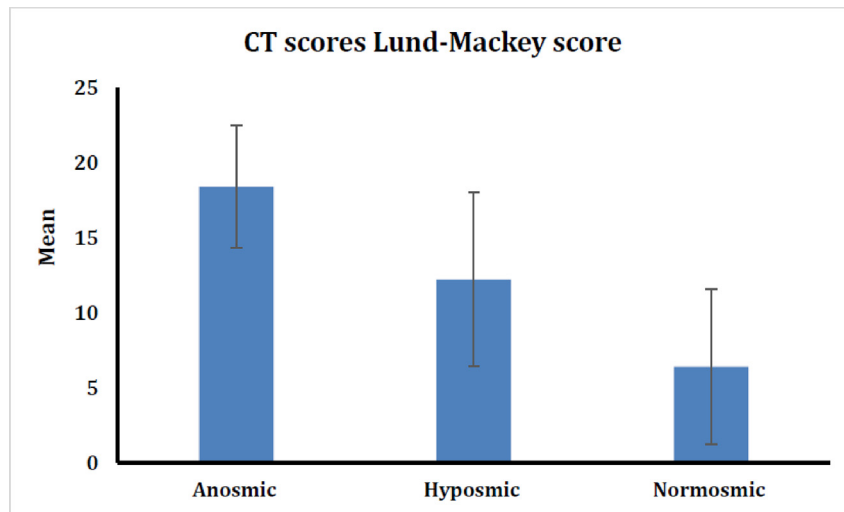


Fig. 4. Lund–Mackay score of the three groups.

found that the score of TDI did not change in 46% of patients and sometimes decreased in 7% of patients after FESS. The possibility of decrease in the sense of smell after FESS is recorded, and its incidence was between 2 and 9% of all patients after surgery [22]. The explanation of their findings might be owing to activation of inflammatory process after surgery.

All patients were divided according to TDI score into anosmic patients ( $n = 26$ ), hyposmic ( $n = 16$ ), and normosmic patients ( $n = 6$ ). The progress of sense of smell differed among the three subgroups. It was found that 75% of anosmic and 26% of hyposmic patients recorded marked increase in the sense of smell after surgery. However, it was found that in normosmic patients there was no increase in sense of smell after FESS. On the contrary, 6% of hyposmic and 33% ( $n = 2$ ) of normosmic patients recorded decrease in olfaction after surgery.

In general, FESS increased the sense of smell, especially in anosmic patients. Although few patients after surgery were normosmic. This may be owing to surgical trauma or more likely owing to continuation of the process of inflammation and olfactory nerve damage [23]. Hence, to improve the olfactory results, FESS should be performed as early as possible when CRSwNP is resistant to medical treatment and with marked decrease in the sense of smell [24].

It was proved in this study that FESS improved the life quality in patients with CRSwNP [25]. These results were matched with previous studies, which confirmed the great progress in SNOT-20 after surgery in patient with CRSwNP [26].

It was found that improvement of olfaction and SNOT-20 after FESS was more evident in anosmic

and hyposmic patients compared with normosmic patients.

It is well known that the results of surgery for patients with CRSwNP depended on surgical technique and proper selection of patients. The actual parameter for success of surgery is the progress of the life quality and enhancement of nasal symptoms. Actually, there are no accurate measurements to assess the results of FESS. Therefore, the decision of surgery is mostly related to the severity of nasal symptoms. As a fact, the surgeon must be able to measure the benefits and hazards of FESS, and therefore, proper selection of patients before surgery is important through accurate preoperative assessment of these patients. The shorter the duration of olfactory dysfunction, the better the outcome of FESS was expected [27].

Although changes of SNOT-20 did not correlate with changes in TDI, decrease in the sense of smell in CRSwNP is associated with affection of life quality [28]. However, improvement of sense of smell and life quality can be used as an accurate parameter for surgical results. Simply, we can use improvement of olfaction and life quality as a prognostic indicator of surgical outcomes of FESS. It was found that there was no correlation between endoscopic findings by Lildholdt score and changes in TDI, which is different to other studies [22]. The explanation of these variations might be owing to different in pathology and degree of nasal polyps of patients with CRSwNP.

Again, the subclassification of patients into anosmic, hyposmic, and normosmic has a direct effect on the postsurgical results. In the anosmic patients, 75% of patients improved after FESS compared with only 26% of patients with hyposmia.

As a fact, preoperative measurement of sense of smell might be a reasonable indicator for surgical results after FESS.

The limitation of this study is relatively low number of patients included in our study and the questionnaire might affect the results, as it is totally subjective and may need some specification and modifications.

## 5. Conclusion

It is well known that patients with CRSwNP improved after surgery with respect to all symptoms, including olfaction and life quality. Preoperative impairment of sense of smell can be used as an indicator for postoperative results. However, preoperative subclassification of patients into anosmic, hyposmic, and normosmic is of great value to detect the possible results of FESS regarding sense of smell and life quality.

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## Conflicts of interest

There are no conflicts of interest.

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