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Impact of endoscopic sinus surgery on smell sensation and nasal airway resistance in patients with chronic rhinosinusitis with bilateral nasal polyposis

Tahany Mohamed Rabie [1], Soad Yehia Mostafa [2], Gehan S Shalaby [2], Fatma Mohamed Elhussieny [2]*, Ahmed Yehia Aboelenen [3], Mohamed Fathy Elsawy [3], Alaa Elkarim Ghanem [2], Ahmed Yehia Fouda [4], Khadiga Abd Allah Abd Rabou [2], Tarek Mohamed Ashmawy [1]

[1] Department of ENT, Faculty of Medicine, Ain Shams University, Cairo, EGYPT
[2] Department of ENT, Faculty of Medicine for Girls, Al-Azhar University, Cairo, EGYPT
[3] Department of Otorhinolaryngology, Armed Forces College of Medicine, Cairo, EGYPT
[4] Department of ENT, Faculty of Medicine for Boys, Al-Azhar University, Cairo, EGYPT
***Corresponding Author:** Fatmaelhossiny.213@azhar.edu.eg

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ABSTRACT

Objectives: The present research set out to assess the impact of functional endoscopic sinus surgery (FESS) on patients' persistent sinusitis-related odor dysfunction. Also, the impact of FESS on nasal airway resistance using an indirect, objective technique, the nasometer.

Materials and methods: A prospective study of 40 patients with bilateral nasal polyposis and smell impairment was conducted. 16 men and 24 women, ages 15-69, with a mean age of 37.7 years, were recruited among E.N.T. clinic attendees at El Zahraa Hospital, Al-Azhar University and El Demerdash Hospital, Ain Shams University from January 2021 till May 2022.

Results: Identifying olfactory impairment before surgery revealed anosmia in 85% and hyposmia in 15%. A considerable improvement was seen after surgery, with anosmia in 32.5% of patients, hyposmia in 10.0%, and normosmia in 57.5%. Patients had an average nasalance level of 31.7 ± 18.9 (3.3-69.7) before surgery and an average oral sentence level of 14.7 ± 10.0 (3.1-46.6). Normal persons have a nasalance score of 54.7 ± 5.8% for nasal phrases. However, it rose to 61.9 ± 13.3, with a range of 16.3-75.1. This requires lowering nasal airway resistance in all surgical patients for up to a year since nasalance and resistance are inversely related.

Conclusions: After endoscopic sinus surgery, olfactory dysfunction and nasalance scores improved. Olfactory impairment is a crucial problem for the quality of life and patient safety of those with chronic rhinosinusitis with nasal polyps, which calls for more investigation.

Keywords: chronic sinusitis, loss of smell, nasal polypi

INTRODUCTION

A complicated, inflammatory disease that affects the linings of the nasal passages and paranasal sinuses and lasts for 12 weeks or more is known as chronic rhinosinusitis (CRS). It is predicted that up to 5% of people may be impacted. Based on whether nasal polyps are present or not, CRS is classified as either CRS with nasal polyps (CRSwNP) or CRS without NP (CRSsNP). Approximately one-third of all CRS cases are represented by CRSwNP. Anosmia (loss of smell), nasal obstruction or blockage, anterior or posterior nasal discharge, and face pressure are symptoms linked to CRSwNP [1, 2]. Significant medical resource consumption and quality of life deficits are linked to the disease, particularly during severe exacerbations [3, 4]. One or more of the following symptoms, with or without facial pain or pressure, nasal blockage, obstruction, congestion, or nasal discharge (posterior/anterior), as well as a reduction in or loss of smell lasting for at least 12 weeks, are indicative of CRS [5, 6].

A multifactorial illness known as CRS affects up to 12% of people in Western nations. The disease's symptoms include headaches, rhinorrhea, nasal blockage, and olfactory impairment. In some situations, topical nasal steroids, nasal washes, antibiotic medication, or systemic steroids are generally acknowledged and advised as standard medical therapy [7, 8].

In addition to the symptoms, nasal polyps and mucopurulent discharge from the middle meatus, with or without nasal mucosa edema and ostiomeatal swelling, confirm the diagnosis of CRS [5, 9].

The most often chosen course of therapy for nasal blockages linked to refractory CRS is functional endoscopic surgery (FESS). Over time, FESS may be able to reduce the intensity and symptoms of nasal blockages significantly. The improvements in nasal resistance, patency, and normal functioning after such surgery have been evaluated subjectively and objectively using anterior active rhinomanometry, acoustic rhinometry, and nasal spirometry [10, 11].

In the USA, olfactory dysfunction affects about 10 million people annually, and the risk rises sharply with age. While hundreds of aetiologies have been linked to its development, viral infection, sinonasal illness (such as nasal polyposis and CRS, or CRMS), and traumatic injury are the three most frequent causes. Two examples of dysfunction are hyposmia, or varied degrees of diminished smell, and anosmia, or total absence of smell. Other dysfunctions include dysguesia, deformed scent, phantosmia, or the inability to detect smell without external stimulation [12, 13].

Surgery, such as septoplasty, turbinoplasty, and FESS, is usually used to remove nasal polyps or inflammatory mucosa to remove nose obstructions. A secondary benefit following these procedures could be improved olfactory function [14].

The majority of patients have surgery to treat recurrent nasal sinus infections, decreased nasal patency, or a pressure-like sensation. Seldom is olfactory impairment treated with surgery alone. Nevertheless, 50-100% of patients report improving their olfactory function after surgery. Studies found that 25% of patients with pre-operative hyposmia and 5% with pre-operative anosmia improved when their olfactory function was evaluated. Nevertheless, olfactory recovery is frequently partial. Others reported that after surgery, the proportion of normosmic patients went from 22 to 36 percent [15].

Following nasal surgery, a small but considerable proportion of individuals will also have some degree of loss of smell. It is crucial to inform patients of the likelihood of olfactory loss after surgery, even if this loss seems to go away with time and appears to be severe in terms of total anosmia in only around 1% of the patients. Not surprisingly, but also predictably, patients with a reasonably high pre-operative olfactory score were most likely to experience this type of loss of smell [16].

It benefits both patients and doctors to assess pre-operative olfactory function. Prior to surgery, any temporary or permanent olfactory abnormalities can be noted, and the patient can be informed. Most patients are unaware that they have a smell issue, which is common in rhinological disorders [17].

Olfactory results after endoscopic sinus surgery (ESS), however, can vary widely and be difficult to forecast. Early research supported ESS's capacity to treat CRS-related olfactory impairment. Nonetheless, a number of more recent, larger prospective studies have advanced our knowledge of how ESS affects olfactory dysfunction linked to CRS and have started to clarify the prognostic variables linked to olfactory improvement [18].

This research aims to confirm how FESS affects nasal airway resistance and smell perception.

MATERIAL AND METHODS

Patients

This study was conducted as a prospective study on 40 patients aged between 15 and 69. There were 16 males and 24 females in the group, and one of the primary nasal symptoms was a complaint of smell dysfunction. There was also evidence of CRS and intranasal polyposis that was resistant to medical therapy. Patients were chosen from among those who visited El-Zahra University Hospital's E.N.T. outpatient clinic. All of them were informed for examination by nasometry and N-butanol threshold test pre and post-operatively.

Methods

All the patients were subjected to the following:

- The nasal obstruction symptom evaluation scale, which is a short, easy-to-complete, valid, reliable, and responsive instrument with potential use for outcomes studies in adults with nasal obstruction, should be used when taking a thorough history. This includes recording any nasal obstruction, discharge, headache, and olfactory disorders [19].
- Careful clinical examination (general and Otorhinolaryngological). Airflow testing is done by simple maneuvers to occlude each side of the patient's nose and ask him to compare the nasal breathing through the two sides or a piece of cotton in front of the nose.

Grading polyp system in [20] in which

- 0–No visible polyps seen,
- 1–Small polyp confined within the middle meatus,
- 2–Multiple polypi within the middle meatus, and
- 3–Polypi extends beyond the middle meatus and sphenoethmoidal recess, and 4- Polypi completely obstructs the nasal cavity.

Investigation

- Routine laboratory investigations to assess patient fitness for surgical intervention, such as complete blood pictures, function tests, liver function tests, fasting blood sugar, and kidney and coagulation profiles.
- Computed tomography scan of the nose and paranasal sinuses, both coronal and axial views. Nasometry (pre- and post-operatively): This test was done at the Speech and Audiology Clinic Ain-Shams University. First, we operated the computer and the nasometer unit. Then, type the menu and select or type NM or NM2 on the DOS command. After that, select capture from the overhead display. The patient should be seated erect with the double microphone, adjusted to be between the upper lip region and the nasal region and adjusted to fit the head. For nasal sentence score: Select capture new patient from the drop list. The patient should say the nasal sentence. Click at the beginning of the speech and again click at the end of the sentence. Select analyze, and then select analyze all data from the drop list. Finally, the results are printed.
- 1–Butanol (n-butyl alcohol) aqueous dilutions are used as the odorant in the butanol threshold test (pre- and

post-operative). Dilution step 0 refers to the greatest concentration (4%) in deionized water. The solution is then diluted by steps 3 through 14. Next, mix one part of deionized water with three parts of 4% n-butanol. This is bottle number one. Then, bottle number two is prepared similarly by getting one part of diluted n-butanol from bottle number one and three parts of deionized water. This dilution continues till bottle number 14. The test solutions were shown in plastic bottles that could be squeezed.

The experiment started with a blank and a low concentration of butanol dilution, such as bottle number 14, which has the lowest concentration. Whichever smelled the strongest had to be chosen by the subject. If the response was incorrect, the concentration was raised; if the response was accurate, the patient received a bottle with a blank and a solution with the same concentration. The olfactory threshold was defined as five consecutively correct responses. A scale representing the degree of sense of smell was developed using the butanol concentration steps: 0-2 = anosmia, 3-6 = hyposmia, and 7-14 = normosmia.

The follow-up period for all patients is every month to 12 months postoperative.

Statistical Analysis

The gathered data were coded, tabulated, and statistically analyzed using IBM SPSS statistics software version 18.0, IBM Corp., Chicago, IL, USA, 2009. For quantitative data that was regularly distributed, descriptive statistics were performed to determine the mean (M) ± standard deviation (SD) and the minimum and maximum of the range. Qualitative data, on the other hand, was done using percentages and figures. For quantitative variables, inferential analyses were performed using the paired t-test, where there were two dependent groups with normally distributed data, and the Shapiro-Wilk test for normalcy testing. Inferential analysis for independent variables was performed by utilizing the McNemar test to determine the agreement between paired categorical data and qualitative data. The significance level taken at $p < 0.050$ is significant; otherwise, it is non-significant.

RESULTS

Table 1 shows the demographic characteristics of the studied cases. M ± SD of age was 37.7 ± 12.4 with a range of 15.0-69.0. Males were 16 (40.0%), and females were 24 (60.0%).

Table 2 shows that nasal obstruction M ± SD scale was 7.0 ± 2.3 with a range of 3.0-10.0; moderate obstruction was in less than half of cases (47.5%), and the remaining cases (52.2%) had severe nasal obstruction.

In endoscopic grading of polyps among the studied cases, the most frequent grade was grade IV in less than half of cases no.17 (42.5%), followed by grade III no. 12(30.0%), while gradeII was the least frequent in 10 cases (27.5%) (**Table 3**).

Table 4 shows that the M ± SD of nasalance score of the nasal sentence before the operation was 31.7 ± 18.9 with a range of 3.3-69.7. After operation, M ± SD was 61.9 ± 13.3 with a range of 16.3-75.1. The M ± SD of nasalance score elevation was 30.2 ± 19.6 with a range of -23.7-57.2. The change was statistically significant.

Table 1. Demographic characteristics among the studied cases

Variables		M ± SD	Range
Age (years)		37.7 ± 12.4	15.0-69.0
Variables		**N**	**Percentage**
Sex	Male	16	40.0%
	Female	24	60.0%
Total		40	100%

Table 2. Nasal obstruction among the studied cases

Variables		M ± SD	Range
Nasalobstructionscore		7.0 ± 2.3	3.0-10.0
Variables		**N**	**Percentage**
Nasal obstructiongrade	Moderate	19	47.5%
	Severe	21	52.5%
Total		40	100%

Table 3. Endoscopic grading of polyp among the studied cases

Grade	N	Percentage
GradeII	10	27.5%
GradeIII	12	30.0%
GradeIV	17	42.5%
Total	40	100%

Table 4. Nasalance score of the nasal sentence among the studied cases before and after surgery

Time	M ± SD	Range	p
Before	31.7 ± 18.9	3.3-69.7	< 0.001*
After	61.9 ± 13.3	16.3-75.1	
^Change	30.2 ± 19.6	-23.7-57.2	

Note. Total = 40; *Significant; & ^Change: After-before (negative values indicate reduction)

Table 5. Right nostril olfactory threshold among the studied cases before and after surgery

Time	M ± SD	Range	p
Before	0.8 ± 1.6	0.0-6.0	< 0.001*
After	6.0 ± 4.0	0.0-13.0	
^Change	5.2 ± 3.9	-2.0-13.0	

Note. Total = 40; *Significant; ^Change: After-before (negative values indicate reduction); & #Paired t-test

Table 6. Left nostril olfactory threshold among the studied cases before and after surgery

Time	M ± SD	Range	p
Before	0.9±1.6	0.0–5.0	< 0.001*
After	5.9±4.1	0.0–13.0	
^Change	5.0±3.8	-2.0–11.0	

Note. Total = 40; *Significant; ^Change: After-before (negative values indicate reduction); & #Paired t-test

Table 5 shows that the M ± SD of the right olfactory threshold before operation was 0.8 ± 1.6 with a range of 0.0-6.0. After operation, M ± SD was 6.0 ± 4.0 with a range of 0.0-13.0. The M ± SD of right olfactory threshold elevation was 5.2 ± 3.9 with a range of -2.0-13.0. The change was statistically significant.

Table 6 shows that the M ± SD of the left olfactory threshold before operation was 0.9 ± 1.6 with a range of 0.0-5.0. After operation, M ± SD was 5.9 ± 4.1 with a range of 0.0-13.0. The M ± SD of left olfactory threshold elevation was 5.0 ± 3.8 with a range of -2.0-11.0. The change was statistically significant.

Table 7 shows the frequency of olfactory dysfunction (OD) Before the operation: Anosmia was in more than three-

Table 7. Frequency of olfactory dysfunction among the studied cases before and after surgery

Time	Smell	N	Percentage
Before	Anosmia	34	85.0%
	Hyposmia	6	15.0%
After (total = 40)	Anosmia	13	32.5%
	Hyposmia	4	10.0%
	Normosmia	23	57.5%

quarters of the studied cases (85.0%), and hyposmia was in the remaining (15.0%). After the operation: Anosmia was in less than a third of the studied cases (32.5%), hyposmia was in (10.0%), and normosmia was in the remaining (57.5%).

DISCUSSION

The present study's goal was to assess nasal airway resistance and olfactory impairment in Egyptian patients with CRSwNP after ESS. Mucosal inflammation, whether or not it culminates in polyp development or mucosal edema, is the main cause of OD in CRS. It may impair olfaction by physically limiting airflow and odorant transfer to an olfactory epithelium that is otherwise healthy [21]. However, olfaction may be directly impacted by inflammation-induced damage to the olfactory epithelium [22].

According to the current investigation, the right nasal side's olfactory threshold was 0.8 ± 1.6, with a range of 0.0-6.0 before surgery. The M ± SD following the procedure was 6.0 ± 4.0, with a range of 0.0-13.0. The right olfactory threshold elevation's standard deviation was 5.2 ± 3.9, with a range of -2.0-13.0. The change was statistically significant and is the same on the left side.

There is conflicting research supporting olfactory enhancement following ESS. Others report no change or even dysfunction [16, 23-26]. The range of improvements is 25% to 100%. Variables in the olfactory results, such as subjective vs objective evaluation, research population, improvement criteria, duration of patient follow-up, or previous olfactory state, may cause this disparity. Counseling patients on postoperative olfactory recovery, therefore, becomes more difficult. Through the use of 31 studies [27], the 40-item smell identification test (3.49, p = 0.0010), the visual analog scales (20.83, p = .001), and the altered taste/smell item on the sinonasal outcome test (21.32, p < 0.0001), the weighted mean differences of olfactory measures showed significant improvement in mixed CRS patients (those with and without polyps). Patients with a combination of CRS and the sniffin' sticks threshold (1.60, p = 0.16) and the brief smell identification test (0.20, p = 0.32) showed non-significant improvements. Patients with polyps and dysosmics showed the greatest degrees of olfactory improvement when they were separated. The sniffin' sticks identification test showed an improvement of 2.57 (p < 0.0001), the sniffin' sticks overall score of 11.54 (p < 0.0001), and the 40-item smell identification test of 7.87 (p = 0.006) for polyp patients. The 40-item smell identification test revealed a 5.75 improvement in dysosmic patients (p = 0.0001). It was also discovered that 80% of hyposmic patients reported a single, solitary decline in their capacity to distinguish between smells [28].

In 70% of cases, postoperative improvements were recorded. Of the hyposmic patients, almost 25% achieved normosmia after surgery, compared to 5% of the anosmic patients.

At a three-month follow-up, it was calculated that olfactory scores in anosmic individuals had improved significantly following ESS [29]. A few hyposmic patients showed improvement following surgery, while others showed no change at all. After surgery, 80% of normosmic individuals showed no change, whereas 20% of them developed hyposmia. Following surgery, none of the normosmic patients developed anosmia.

The study in [30] included 157 individuals who had nose surgery. Half of the patients said they had an excellent sense of smell before surgery, and the other 50% said they had a poor sense of smell. Following surgery, 30% of patients reported a subjective improvement in their ability to smell, 1% reported a decline in their ability to smell, and 69% reported no change at all.

It was discovered that a number of factors influence the degree of olfactory recovery following surgery for nasal polyps; these factors include increased eosinophilic count, a high pre-operative Kennedy and Lund Mackay score, and recurrent surgery [31].

The study in [32] did a full review that showed that the improvements in smell in CRSwNP patients were more than the minimum level needed to be clinically meaningful for both the SIT-40 and sniffin' sticks (burghart) tests (≥ 4.5 and ≥ 4.1, respectively).

The study in [33], which looked into how endoscopic sinus and polyp surgery could improve smell in people with CRS, found that 32.9% of patients on the right and 28.8% of patients on the left were anosmic, while 8.2% and 5.5% of patients had normal smell. On the right side, the rate of olfactory improvement was 68.5%, whereas on the left, it was 67.1%. Even though two instances (2.74%) experienced anosmia following surgery, both sides' overall olfactory scores dramatically improved.

The study in [34] did a meta-analysis study and found that people with CRS who had nasal polyps had better OD. They measured this with the University of Pennsylvania smell identification test (p = .046), the sniffin' sticks total score (p = .000), the sniffin' sticks discrimination score (p = .023), the sniffin' sticks identification score (p = .005), and the visual analogue scale (p = .000). Nonetheless, there was no discernible improvement in the sniffin' sticks test threshold score (p = .361).

According to research in [35], two-thirds of ESS patients had no postoperative problems, including bleeding, vision loss, olfactory function loss, and spinal fluid leakage.

Approximately 19% of the patients had postoperative reports of loss of olfactory function; one in five patients has OD. Furthermore, less than half of the patients (42.3%) barely notice perfumes.

Patients with nasal polyps, those with CRS for more than a year due to persistently irritated mucosa, and men exhibited notably greater levels of olfactory impairment. This is because nasal polyps and chronically irritated mucosa block the nasal channel, which may cause a loss of smell. Furthermore, postsurgical olfactory impairment was seen in individuals who had just had surgery [35], as well as those who had taken steroids before the surgery.

Our results, which demonstrated a statistically significant improvement in the right and left olfactory thresholds before and after surgery, are consistent with all previous research.

Several factors have led to the different outcomes and results of previous studies. These include the atrophic changes of the olfactory neurons, the pathology going away in some cases, the effects of some useful nasal local drugs after long-term use, and the pathology returning.

The nasalance score improved statistically significantly, according to our study. The nasal sentence's M ± SD of nasalance score elevation was 30.2 ± 19.6, with a range of -23.7-57.2. This indicates that there was a statistically significant change.

Similar to [36], the M ± SD of the nasalance score elevation for the oral sentence was 8.4 ± 12.6 with a range of -15.3-53.7, and it was statistically significant. They found that there had been a significant improvement in all patients nasal obstruction values (100%; $p < 0.001$) and in 62 patient voice handicap index-10 questionnaire scores (98%; $p < 0.001$). After treatment, all patients' nasalance ratings increased (100%; $p < 0.001$).

In contrast to [37], who demonstrated that nasal resonance alterations following FESS are negligible and imperceptible,

CONCLUSIONS

In conclusion, OD is a common clinical symptom in people with CRS. In this study, after ESS, there was an enhancement in nasalance and OD assessments. Olfactory impairment requires further examination as it significantly jeopardizes patients' quality of life and safety in cases of CRS. Extensive investigations are recommended to precisely assess OD after endoscopic surgery, including the initial complaint, medical conditions, duration of follow-up, and degree of CRS.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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