Olfactory function in patients with chronic rhinosinusitis before and after functional endoscopic sinus surgery

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Background: Olfaction plays important roles in taste, warning of danger, and the triggering of emotions and memories. As per estimates available, 61% to 69% of Patients with Chronic rhinosinusitis have a reduced sense of smell. The aim of this work: is to evaluate whether functional endoscopic sinus surgery (FESS) significantly altered olfactory function, as measured by tests of odor identification, detection and discrimination like Sniffin Sticks test.

Methods: This study included 40 patients indicated for functional endoscopic sinus surgery due to chronic rhinosinusitis resistant to medical treatment with hyposmia or anosmia. Olfactory function evaluation was done pre and post-operative through subjective and objective tests (by questionnaire and Sniffin Sticks Test).

Result: Through 40 patients with male/female (24/16). The olfaction in 37 patients was improved (37/40) and remained the same as pre-operative in 3 patients (i.e thirteen patients were improved to complete ability of smell, seventeen patients were improved to most of time good sense of smell, four patients were improved to sometime no smell, three patients were improved from no smell to most of time no smell).

Conclusion: FESS for the chronic rhinosinusitis cases resistant to medical treatment with doing good postoperative care has good impact on the outcome results of olfaction and its improvement.

Keywords: Olfaction, FESS, chronic rhino-sinusitis, sniffin test.

Highlights:
- CRS greatly affects the olfaction.
- FESS has obvious role in the improvement of olfaction.
- No statistically indicator for the post-operative results.

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Introduction

Olfaction plays important roles in taste, warning of danger, and the triggering of emotions and memories. [1] Among the various causes of olfactory disorders, nasal and sinus diseases are very important as they are the most treatable causes of olfactory loss. [2] As per estimates available, 61% to 69% of Patients with Chronic rhinosinusitis (CRS) have a reduced sense of smell. [3]

Medical and surgical treatments of chronic rhinosinusitis (CRS) have different rates of success in improving the sense of smell in various pathologies. Some reports claimed that only medical therapy using corticosteroids has effect on improving the olfactory sensation. Few studies on the outcome of functional endoscopic sinus surgery (FESS) have dealt with the effect of the surgery on the sense of smell and they found contrasting results. [4] However, most of these studies measured olfactory acuity in frank polyposis cases or patients with established allergic rhinitis, with little mention about non-polyposis cases. [5]

Aim of the work

The aim of this work is to evaluate whether functional endoscopic sinus surgery (FESS) significantly alters olfactory function or not, as measured by tests of odor identification, detection and discrimination like Sniffin' Sticks test.

Methodology

This study was conducted at Al Kasr Al Ainy hospital at the period from February 2017 till February 2018, and included 40 patients indicated for functional endoscopic sinus surgery due to chronic rhinosinusitis without polyposis (as proved by clinical endoscopic examination and CT Scan of the paranasal sinuses especially for the area of the Olfactory cleft between the middle and superior turbinates laterally and the nasal septum medially) whom were resistant to medical treatment and were presented with hyposmia or anosmia. Olfactory function evaluation was done pre and post-operative through subjective and objective tests (by questionnaire as per Babak S et al., in 2013 and Sniffin Sticks Test as per Hummel T et al., in 1997. [4,6] All patients were subjected to the routine history with full endoscopic examination and CT scan imagining to obtain clinical and radiological staging of rhinosinusitis. With exclusion of pregnant women, patients with immunodeficiency, autoimmune diseases, cystic fibrosis, visible polyposis, previous sinonasal surgery, asthma or patients with apparent anatomical abnormalities.

Statistical methods: The clinical and laboratory data were statistically analyzed by using Microsoft Excel 2010 and SPSS v19.0 to obtain Descriptive statistics and Analytical studies using for these Wilcoxon test, Chi-square test, Pearson correlation and Spearman correlation.

Results

This study included a total of forty patients with CRS with olfactory dysfunction not responding to medical treatment who underwent FESS. Our study included 24 males representing 60% of the total cases and 16 females representing 40%. The age ranged from 17 till 53 with mean value 34.25 +/- 9.16. The olfactory dysfunction duration of the patients ranged from 1 year to 6 years, with mean value 2.70 +/- 1.47. Lund-Mackay scoring of CT scan of patients ranges from 8 till 18, with mean value 10.75 +/- 2.27 **(Table 1)**.

Statistically, there was significant difference between pre and post-operative patients rating of their olfactory condition after doing FESS (P value < 0.001). Pre-operative olfactory sensation rating was minimum 1 and maximum 3 with mean value 2.22 +/- 0.66. While post-operative olfactory sensation rating was minimum 1 and maximum 5 with mean value 3.85 +/- 1.12 **(Tables 1,2)**.

Regarding Sniffin' Sticks test scoring pre and post-operative, there was also statistically significant difference (P value<0.001). Pre-operative scoring was minimum 0 and maximum 6 with mean value 3.18 +/-1.14. Post-operative scoring was minimum 4 and maximum 12 with mean value 8.72 +/- 2.24 **(Table 1)**.

Concerning both Olfaction rating & sniffin test scoring; Pre-operative, there was a significant relation (inverted proportionate relation) as the correlation coefficient value was -0.603 & -0.500 respectively (i.e., the more the Lund-Mackay score, the less the pre-operative olfaction rating & sniffin test scoring), and statistically significant difference as P value was <0.001 & 0.001 respectively, while post-operative there was also inverted proportionate relation as the correlation coefficient value was -0.259 & -0.305 respectively (i.e., the more the Lund-Mackay score, the less the post-operative olfaction rating & sniffin test scoring) , but there was no statistically significant difference as P value was 0.106 &0.056 respectively **(Table 3)**.

Concerning the relation between both pre and post-operative olfactory rating and scoring and the duration of olfactory impairment pre-operative, there was no statistically difference between any of these, but there was inverted proportionate relation between both pre and post-operative olfactory rating and scoring with the duration of olfactory impairment pre-operative **(Table 4)**.

Table 1. Showing Age, Olfactory dysfunction duration, Pre-operative CT scan Lund-Mackay scoring, Pre & post Olfactory sensation rating and sniffin sticks scoring.

	Mean	Standard Deviation	Median	Minimum	Maximum	P value
Age	34.25	9.16	34	17	53	
Olfactory Dysfunction Duration (years)	2.7	1.47	2	1	6	
Pre-Operative CT Scan Lund-Mackay Score	10.75	2.27	10	8	18	
Pre-operative Olfactory Sensation Rating	2.22	0.66	2	1	3	< 0.001
Post-Operative Olfactory Sensation Rating	3.85	1.12	4	1	5	
Pre-Operative Sniffin' Sticks Score (Identification Score)	3.18	1.41	3	0	6	< 0.001
Post-Operative Sniffin' Sticks Score (Identification Score)	8.72	2.24	9	4	12	

Table 2. Pre & Post-operative olfactory sensation rating of the studied cases.

Pre-operative Olfactory Sensation Rating	complete inability to smell	5	12.50%
	most of time no smell	21	52.50%
	sometime no smell	14	35.00%
	most of time good smell	0	0
	complete ability to smell	0	0.00%
Post-Operative Olfactory Sensation Rating	complete inability to smell	1	2.50%
	most of time no smell	6	15.00%
	sometime no smell	4	10.00%
	most of time good smell	16	40.00%
	complete ability to smell	13	32.50%

Table 3. Correlation between pre-operative CT Scan Lund-Mackay Score and the pre & post-operative olfactory sensation rating and Sniffin' Sticks Score.

		Pre-Operative CT Scan Lund-Mackay Score
Pre-operative Olfactory Sensation Rating	Correlation Coefficient	-.603-
	P value	<0.001
	N	40
Post-Operative Olfactory Sensation Rating	Correlation Coefficient	-.259-
	P value	0.106
	N	40
Pre-Operative Sniffin' Sticks Score (Identification Score)	Correlation Coefficient	-.500-
	P value	0.001
	N	40
Post-Operative Sniffin' Sticks Score (Identification Score)	Correlation Coefficient	-.305-
	P value	0.056
	N	40

Table 4. Correlation between duration of olfactory dysfunction pre-operative and the pre & post-op CT Scan Lund-Mackay Score, olfactory sensation rating and Sniffin' Sticks Score.

		Olfactory Dysfunction Duration (years)
Pre-Operative CT Scan Lund-Mackay Score	Correlation Coefficient	0.142
	P value	0.383
	N	40
Pre-operative Olfactory Sensation Rating	Correlation Coefficient	-.002-
	P value	0.99
	N	40
Post-Operative Olfactory Sensation Rating	Correlation Coefficient	-.058-
	P value	0.722
	N	40
Pre-Operative Sniffin' Sticks Score (Identification Score)	Correlation Coefficient	-.078-
	P value	0.632
	N	40
Post-Operative Sniffin' Sticks Score (Identification Score)	Correlation Coefficient	-.057-
	P value	0.728
	N	40

Discussion

CRS is one of the most common diseases and sometimes presents with olfactory impairment, which may, at times, be the lone clinical presentation. [5]

Olfaction is a multifaceted process that is affected by chronic sinusitis. The most probable explanation is a combination of factors including a mechanical blockade to airflow, neuroepithelial edema and the direct neurotoxic effects of viruses and bacterial toxins. [4]

The goal of FESS for medically refractory CRS is to optimize sinus function and improve access for topical medical therapy, hence alleviate the patient's symptoms. There is substantial evidence for the beneficial effects of FESS on CRS-related outcomes such as endoscopic scores, CT grading, histologic markers and patient symptoms. However, olfactory outcomes following FESS can be variable and challenging to predict. [7]

The aim of this study is to evaluate whether FESS significantly alters olfactory function as measured by a questionnaire answered by the patients and Sniffin' Sticks test. Our study is unique in the context as it specifically focused on patients with CRS but without apparent nasal polyps by pre-operative nasal endoscopic examination.

This study included patients with CRS with hyposmia or anosima which is resistant to several trials of medical treatment at least two courses of local corticosteroids and antibiotics, FESS was done to all patients after failure of medical treatment. In our study we excluded patients with immunodeficiency, autoimmune diseases, cystic fibrosis,

visible polyopsis, previous sino-nasal surgery or asthma.

The result of this study confirmed the efficacy of FESS on smell improvement in patients with CRS (80% of our patients experienced better olfactory affection post-operatively). Pre-operative, 5 patients (12.5%) rated their olfactory condition with 1, 21 patients (52.5%) rated their condition with 2, 14 (35%) patients rated their condition with 3, while no patients rated their olfactory condition with 4 or 5 in our study. Post-operative, we had only 1 patient (2.5%) rated his condition with 1, 6 patients (15%) rated their condition with 2, 4 patients (10%) patients rated their condition with 3, while 16 patients (40%) rated their condition with 4 and 13 patients (32.5%) rated their condition with 5. Regarding olfactory scoring, the median score was 3 pre-operatively and became 9 post-operatively. So, there was statistically significant effect of FESS on olfactory function in these patients.

Similar to our study, Divaya G et al., in 2015 also found as many as 70% of patients with CRS were affected by olfactory impairment. They noted significant improvement in olfaction in 24 of 28 or in 86% of the patients 3 months after surgery. The mean composite scores of all the patients before and after surgery was compared for different odors like butanol-l, peppermint, lemon, clove, and ethyl acetate, and they also used VAS to rate the patients olfaction. They also chose their patients with the same criteria of the patients in our study, patients without visible nasal polyps, asthma, previous nasal surgery, and also with the same medical protocol pre-and post operative. The difference in pre and post-operative scores was highly significant in all the odor categories. [5]

Babak S et al., in 2013 found that 77% of patients showed subjective smell rating improvement after surgery. They used UPSIT test to evaluate the olfactory function scoring and VAS to rate the patients' olfaction. At this study, unlike ours, they didn't exclude patients with polyposis, asthma or previous nasal surgery, but the patients followed the same as our medical treatment regimen before and after surgery. Although the majority of cases in his study was with patients with polyposis (68%), that didn't make their results different than ours, as pre-operative, they found patients with polyposis had poorer smell, while after surgery the results showed the patients without polyposis had better changing in their olfaction. The probable explanation is a direct toxic effect of inflammation from rhino-sinusitis on olfactory epithelium. [4]

Also Perry and Kountakis in 2003 reported 178 patients to his study, where the average pre-operative olfactory function rating was 4.9 +/- 1.8 (as patients was asked to rate their olfaction from 0 to 10 with 0 being normal sense of smell and 10 being complete loss of olfaction). This study included patients with or without visible nasal polyps and also asthmatic patients, but almost with the same medical treatment before and after surgery. At 3 month post-operatively the average rating was 1.8 +/- 0.6, meaning that 86% of patients indicated improvement in their olfactory function, 11% claimed no change and 3% reported worsening of their condition. [8]

In another aspect, Litvack et al., in 2009 reported a prospective trial of 111 patients with olfactory impairment undergoing FESS for CRS. They excluded patients with immunodeficiency, auto-immune disease or cystic fibrosis, but didn't exclude patients with visible polyposis, asthma or previous nasal surgery. They used the UPSIT to evaluate the patients olfaction scoring before and after surgery. Their results demonstrated that olfactory function improved following FESS for anosmic patients (their average score changed from 9.7 to 21.3) but not for hyposmic patients (their average score changed from 28.8 to 30). In fact, anosmic patients with nasal polyposis improved significantly more than patients without polyposis. They hypothesized that anosmic patients had a mechanical obstruction to the olfactory cleft that was amenable to be removed surgically, while hyposmic patients were likely suffered from a multi-factorial etiology of smell impairment with chronic inflammation and damage which was less amenable for optimization by surgery. [9]

Also Pade and Hummel in 2008 evaluated 206 patients with olfactory impairment who elected FESS for CRS. They didn't exclude patients with polyposis in their study unlike ours, but they used the Sniffin' Sticks test to evaluate patients' olfaction pre and post-operative like in our study. They demonstrated that 23% of patients receive improvement, 68% received no improvement and 9% got worse after FESS. They couldn't find exact explanation for these pessimistic non-satisfactory results. They assumed that surgery removes/damages olfactory neurons in the olfactory epithelium, and also claimed that factors that might contribute to the observed post-operative change of olfactory function in some patients may be also relate to changes in intranasal airflow, specifically a number of studies suggest that certain intranasal volumes significantly correlate with olfactory function. [10]

In contrast to the above studies, Jiang et al., in 2008 they demonstrated that FESS has no impact on olfactory function improvement. Their study included 70 patients, excluding patients with previous nasal surgery and immunodeficiency, but didn't exclude patients with nasal polyps. To evaluate the patients' olfaction score before and after surgery, they used VAS, UPSIT, Smell Threshold Test (STT) and Odor Memory Test (OMT). 74.3% of the patients reported by VAS olfaction impairment pre-operative, and 68.6% reported olfaction impairment post-operative. No pre or post-operation differences were observed for either UPSIT or OMT scores, only a small significant improvement was noted in the STT score. They hypothesized that these findings reflect the severe nature of the olfactory deficit initially present in these patients and the fact that chronic inflammation with olfactory membrane is likely to have remained after FESS, such inflammation is believed to be the primary reason of olfaction affection in patients with severe rhinosinusitis. [11]

In another article by Jiang et al., in 2009 they tried to identify predictive factors for olfactory improvement following FESS in patients with medically refractory CRS. The results showed no predictive correlation between olfactory improvement following FESS and the severity of CRS, degree of nasal obstruction, allergy status or the presence of sino-nasal polyposis. [12]

In our study we found no significant correlation with age or gender with the pre or post-operative scoring or rating.

Babak S et al., in 2013 found no significant difference between gender and pre or post-operative smell, and non significant difference between age and pre-operative olfactory function scoring using UPSIT, while there was significant relation between age and post operative scoring, with higher score for young patients and lower score for older patients. They assumed that this may be explained by better tissue regeneration and recovery in younger patients than older ones. [4]

While Perry and Kountakis in 2003 reported that men had a higher pre-operative olfactory scores than women (average score 5.7 for men, and 4.1 for women), as patients were asked to rate their olfaction from 0 to 10 with 0 being normal sense of smell and 10 being complete loss of olfaction. But with slight difference at post- operative scores, as at 6 months post operatively men score was 1.5 while women

score was 1.1. [8]

Regarding pre-operative CT scan Lund-Mackay, we found that there is inverted proportionate relation between the pre-operative Lund- Mackay score and all of pre and post-operative olfaction rating and scoring (i.e., the more the Lund-Mackay score, the less all of pre and post-operative olfaction rating and scoring). And there was statistically difference only between the pre-operative Lund-Mackay score and the pre-operative olfaction rating and scoring.

Babak S et al., in 2013 found significant relation between CT scan Lund-Mackay scoring and the ability to smell pre-operatively (P value = 0.001) and post-operatively (P value = 0.027). While, there was moderate significant difference between pre-operative Lund-Mackay scoring and the post operative scoring using UPSIT. [4] Also regarding pre-operative CT scan Lund-Mackay score, Perry and Kountakis in 2003, their results showed correlation with the pre-operative olfactory score (P value was 0.01), while there was no significant value with the post-operative olfactory score like our study results. [8]

We also found inverted proportionate relation between the duration of olfactory dysfunction pre-operative and both pre and post olfactory sensation rating and scoring as well (i.e., the more the duration of olfactory dysfunction the less the pre and post-operative olfaction rating and scoring). But there was no statistically significant difference between the duration of olfactory dysfunction pre-operative and both pre and post-operative olfactory sensation rating and scoring.
Also Babak S et al. in 2013, found no statistically significant difference between the duration of olfactory dysfunction pre-operative and both pre and post-operative olfactory sensation rating and scoring. [4]

Although it is difficult to compare these studies because of the variation in the case selection criteria and differences in olfactory tests used for the study, but it was also difficult to find pre-operative predictive factors for the improvement of olfactory dysfunction following surgery, whether it was age, gender, severity of CRS, pre-operative CT scan Lund-Mackay score, duration of pre-operative olfactory dysfunction, or any other factors.

Conclusion
In overall points of view, we can consider FESS as an efficient tool in most patients with sinusitis related smell problems. Although olfactory dysfunction improvement following FESS is challenging to predict.

The greater the extent of the disease the more affection of the olfactory function, but with non-statistically indicator for the post-operative results.

There is no relation between the pre or post-operative rating and scoring and the duration of the pre-operative smell affection.

Finally, to get more data and more valuable statistics, there should be more studies on a larger number of cases (may be multicenter) with the same method of olfaction evaluation and standardization of both inclusion and exclusion criteria.

Compliance with ethical standards.
Funding
No funding was received.

Conflict of interest
The authors declare that they have no Conflict of interest.

Ethical approval
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent
Informed consent was obtained from all individual participants included in the study.

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