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AN OBSERVATIONAL STUDY TO ASSESS THE CORRELATION OF PREOPERATIVE AND POSTOPERATIVE OLFACTORY FUNCTION AFTER SEPTAL CORRECTION

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Abstract:

Background: In a worldwide survey, it was reported that 1.2 per cent of the population suffered from olfactory dysfunction. However, olfactory dysfunction is often neglected by clinicians because of difficulty in quantifying the olfactory sense and the lack of a simple, cheap and reliable olfactory test. Olfactory evoked response testing is sophisticated but impractical for daily clinical practice.

Objectives: The main aims and objectives of our study were to study the subjective and objective assessment of olfactory function in patients with deviated nasal septum undergoing septoplasty.

Methods: All patients included in the study were evaluated in detail with clinical history included short form nasal questionnaire, history using visual analogue scale for subjective grading of olfactory dysfunction, Test of olfaction, Routine ENT examination including anterior Rhinoscopy, where the deviation of nasal septum was assessed in detail, Anterior rhinomanometry using nasal olives, Diagnostic nasal endoscopy, biochemical tests like Hematological and urine analysis.

Results: The preoperative and postoperative VAS score was found to be statistically significant [rho= -0.713, p=0.000(<0.001)]. The preoperative and postoperative SFNQ scores and composite olfactory scores and the correlation was found to be significant [rho= -0.497, p=0.001(<0.001)]. The pre and postoperative rhinomanometry nasal air flow scores during expiration and inspiration was found to be significant [rho= 0.771, p=0.000(<0.001)].

Conclusion: As earlier studies our study also found improved olfactory function following septoplasty mainly because of increased nasal airflow caused by correction of deviated nasal septum.

Keywords: Active Anterior Rhinomanometry (AAR), Odor Identification Testing, Olfactory Function, Rhinoplasty, Septoplasty, Smell Dysfunction.

Introduction

The sense of smell is an extremely important sense for humans as well as animals.1 Loss of olfactory function affects the patient's appreciation of food and drink; it has impact on safety (e.g., detection of spoiled foods and smoke); and it may also produce bodily insecurity. However the loss of olfaction can be particularly insidious and escape detection because, unlike loss of sight or hearing, it is not apparent to others.2

In a worldwide survey, it was reported that 1.2 percent of the population suffered from olfactory dysfunction.3Smell dysfunction is of considerable significance to those whose livelihood depends on its normal functioning as well as to the

average individual. Many persons decrease their food intake and lose weight because of the loss of flavor secondary to smell loss, becoming, in some cases, despondent and depressed as a result of the lack of enjoyment of eating.4Loss of smell can result in significant psychological disruption and even generate feelings of physical and social vulnerability and victimization.5

It is well established that the structure of nasal cavity determines the pattern of airflow through the human nose. The pattern of airflow affects the supply of odorant molecules to the olfactory cleft. Leopold DA studied the relationship between nasal anatomy and human olfaction and found that there is a relationship between changes in the structure of the upper nasal cavity and changes in olfactory ability.5 Shape and volume of the nasal cavity influence olfactory function. They have a strong impact on intranasal airflow and thus on the number of odorant molecules transported to the olfactory epithelium. Several studies have focused on the relationship between the intranasal airflow and olfactory function.6

Nasal obstruction is one of the most common problems bringing a patient into a physician's office, and septal deviation is a frequent structural etiology.7 The septum is the wall that divides the nose down the middle, into a right and left side. It is made of cartilage and bone and has a mucous membrane lining on both sides. When the septum is straight, it simply acts as the divider of the nose and allows for streamlined, aerodynamic airflow and easy nasal breathing. If it is deviated or twisted, it can cause nasal obstruction. The septum can twist to the right and block the right side, and then come around further back in the nose and twist to the left to block the left side as well. There is no medicine that can straighten a deviated septum. If the septum is causing nasal obstruction, only surgery can correct it. This surgery is called a septoplasty.8

Mere nasal inspection is an inadequate source of information as far as nasal patency is concerned and anatomical deformity of the nose does not necessarily result in a functional disturbance of the nasal airway, but it affects the measured pressure flow data and calculated nasal resistance. The Standardization Committee on Objective Assessment of Nasal Airway decided that active anterior rhinomanometry (AAR) should be the method of choice to measure nasal ventilation. Active AAR is especially important because it gives information on both nasal cavities separately and it is the most physiological way of measurement. Rhinomanometry is generally accepted as the standard technique of measuring nasal airway resistance and accessing the patency of the nose. Nasal resistance is calculated by measuring the flow through the nose and also the pressure of force required to cause the airflow.9

In contrast to other disorders of special senses like audition and vision, smell alterations tend to be misunderstood or dismissed by patients as well as by physicians which leads to poor understanding of olfactory physiology, lack of widely accepted odor classification, partial inadequacy of instruments for measuring olfactory dysfunction, relatively low awareness of the disturbance by the people affected and, possibly as a consequence of all of this, widespread lack of interest in this subject on the part of medical practitioners. Olfactory or taste dysfunction sometimes occur as secondary processes in a number of diseases, but often a reduced ability to smell or a distorted olfactory experience is a patient's primary complaint.11

Although otorhinolaryngologists are often the first physicians whom patients with smell complaints visit, some patients find themselves making repeated visits to multiple physicians until their olfactory problem is adequately addressed. Most patients who complain of decreased 'taste' function actually have an unrecognized impairment of smell. Diminished 'taste' is typically due to loss of flavor sensations derived from retronasal stimulation of the olfactory receptors, rather than impairment of tastebud-mediated sensations, per se. Importantly, a patient's lack of olfactory function can be an early sign of a number of serious disease states, including nasopharyngeal carcinoma, Alzheimer's disease, Parkinson's disease, frontal meningiomas, multiple sclerosis (MS) and sinus infections.4

The necessity of the physician to properly evaluate for abnormalities of smell function is also supported in the medico-legal arena, with

claims of accidental and iatrogenic smell disturbance often resulting in substantial financial awards. Routine clinical quantitative measurement of smell function can now be easily performed in the office setting, allowing a physician to validate and characterize a patient's olfactory complaint; identify patients who might be malingering; quantify and document known presurgical smell impairment; and longitudinally follow the course of smell function in the midst of a therapeutic intervention or during recovery from previous loss.5

The olfactory neuroepithelium, which harbors the sensory receptors of the main olfactory system and some cranial nerve V free nerve endings, lies in the upper recesses of the nasal chambers, including the cribriform plate, superior turbinate, and sectors of the middle turbinate.12

Studies have correlated the sense of nasal obstruction with deviated nasal septum and have correlated the anatomical deviation with nasal resistance measurement using anterior rhinomanometry. The effect of septal surgery on olfaction has also been studied by Pfaar O, 11 and Hummel T,14 who found that olfactory thresholds were related to nasal obstruction resulting from nasal septal deviation.

We proposed to study the effect of deviated nasal septum on nasal function, primary focus being the olfactory thresholds and odor identification ability and the change observed if any after septal correction.

Materials and Methods

The prospective study was conducted in the Department of Otorhinolaryngology, Dr. D. Y. Patil Medical College, Navi Mumbai (Maharashtra), in the year March 2008 to March 2009, over a period of one year. An ethical clearance was obtained from the institutional committee prior the study.

Inclusion Criteria: Patients of 15 to 50 years having deviated nasal septum presenting with nasal obstruction.
Exclusion Criteria: Patients suffering from acute rhinitis, chronic rhinosinusitis with or without nasal polyps, atrophic rhinitis, granulomatous diseases of nose, intranasal neoplasm, nasal masses, patients on treatment with any drugs known to affect olfaction and having past history of nasal surgery.

Assessment of Olfactory Dysfunction

Preoperative assessment: All patients included in the study were evaluated in detail with clinical History included short form nasal questionnaire,41History using visual analogue scale for subjective grading of olfactory dysfunction, Test of olfaction, Routine ENT examination including anterior Rhinoscopy, where the deviation of nasal septum was assessed in detail, Anterior rhinomanometry using nasal olives, Diagnostic nasal endoscopy (Lana and Kennedy),11,12 biochemical tests like Hematological and urine analysis.

Patients were taken for septoplasty under local anesthesia. Routine procedure was followed. Nasal pack was removed after 48 hours and patients were kept under regular follow up.

Postoperative assessment: All tests and procedures were repeated after four weeks of surgery. At the same time subjective improvement in nasal obstruction and olfactory dysfunction was assessed using visual analog score for olfaction on a five point scale and short form nasal questionnaire for nasal symptomatology. The olfactory scores were correlated with the value of nasal resistance. Subjective change in olfaction and nasal obstruction was correlated through the visual analog scores.

Olfactory Test Methodology: The test used by us was a modification of CCCRC and COT test and therefore the test comprised of two components namely:

Threshold Testing: The threshold test employed 1-butanol as the test odorant. 1-butanol is commonly used in odor experiments as it is low in toxicity, colorless, water-soluble, and readily available in high purity and has a neutral odor quality. It has attained wide acceptance as a reference odorant in various applied settings because of these same attributes.37 the test kit contained nine glass bottles each containing ~20ml of test solution which were labeled as, solutions one to nine and another identical glass

bottle filled with ~20ml of sterile water. The 1-butanol solution was diluted by successive factors of three; the highest concentration being 4% (vapor phase of approximately 3,000ppm),37 designated as solution one while lowest concentration being 0.00061%, designated as solution nine.3Participants received two bottles at a time, one with sterile water and one with odorant (solutions one to nine). The test begins with the weakest solution in an ascending order of concentration to avoid neural adaptation. The patient needs to identify the bottle containing odorant on four successive occasions. The lowest concentration of odorant that the patient had identified was defined as the threshold. Scores of one to nine were given depending on the lowest concentration of solution successfully identified. Zero is scored if solution one is not identified.3Testing was done for the other nostril in the similar manner after determination of the threshold in one nostril.

Odor Identification Testing: The odorants which were used in the CCCRC and COT odor identification tests were modified for the study according to our local dietary and cultural habits. To perform the test, the substance was smelled by the subject for approximately 3 seconds without any force. There was an interval of at least 30 seconds between successive presentations to prevent olfactory desensitization.36Patients were asked to choose from a list of four choices for each substance presented. Ten items were presented in random order for monorhinic smelling.37 To restrict the stimulus to one nostril, the participant was asked to hold the irrelevant nostril closed. The total odor identification score was calculated by adding the number of substances correctly identified. The total score of the threshold test and the odor identification test was taken up as the combined olfactory score for the nostril being tested.

Both the tests were done in a well-ventilated and quiet room. The approximate amount of time spent on the whole test was 8-10mins for each patient.

Nasal airway resistance(NAR) was measured in each nostril by using active anterior Rhinomanometer (AAR) by methods described by International Rhinology society.

Statistical analysis was done by SPSS 22 statistical software. Pearson correlation and Paired t-test was used for comparing preoperative and postoperative flow rate values on rhinomanometry.

Results

Over a period of 1 year, a total of 41 subjects were prospectively recruited. All the subjects of deviated nasal septum were taken. The age of the subjects ranged from 15 to 45 years with mean age of 25.51 yrs. The patients consisted of 27 males and 14 females with a male female ratio of 1.9:1.A detailed history was taken followed by ear, nose and throat examination. Patients presenting with nasal obstruction and having deviated nasal septum on examination were included in the study. Patients were also asked to grade their sense of nasal obstruction preoperatively and postoperatively on a scale of 0-4, by answering a short form nasal questionnaire (SFNQ). Grade 4 being the score given when the nasal obstruction was very severe and 0 was given when there was no nasal obstruction. The mean score of SFNQ in preoperative period was 16.20±3.494.

These patients were asked to grade their sense of olfaction preoperatively and postoperatively on a visual analogue score (VAS) from 0 – 5 with grade of ‘5’ being very poor and grade ‘0’ being almost normal. The mean score of VAS in preoperative period was 3.27±0.633. Olfaction was evaluated in all these subjects preoperatively and postoperatively using a test with two components namely, threshold detection and odor identification. The composite olfactory score of left and right side nasal cavity was 11.78±3.953 and 10.61±4.067 respectively. Anterior rhinoscopy was done in all patients and the deviation was graded in 1-3.

Rhinomanometry was used for objective assessment of nasal obstruction in all patients preoperatively and postoperatively.

Table 1: The mean values of NAF (cm3/sec) in preoperative period were as follows:

	During inspiration(NAF)	During expiration(NAF)
Diseased side	219.24±87.296	252.40±84.986
Non diseased side	324.29±98.531	384.85±108.578

Nasal endoscopy evaluation was done in all patients. The visibility of olfactory cleft was evaluated in preoperative period. The olfactory cleft on diseased side was visible in 12 patients and on non diseased side it was visible in 31 patients. Nasal endoscopy scoring was done according to Lanza and Kennedy scoring.

In all patients the extent of posterior septal deviation was evaluated by using nasal endoscopy in preoperative period. On diseased side posterior septal deviation was visible in 10 patients. Posterior septal deviation was absent in all patients on non diseased side.

On the basis of side of deviation of septum on anterior rhinoscopy, the sides of nasal cavities were divided into diseased (where the septal deviation was present) and nondiseased (normal) side.

The range of composite scores in preoperative period on the diseased side (where the deviation is present) was from minimum 4 to maximum 14, mean score being 7.90±2.234. The range of composite scores in preoperative period on the nondiseased side was from minimum 9 to maximum 18, mean score being 14.49±2.378.

The severity of deviated nasal septum on anterior rhinoscopy and preoperative combined olfactory scores of diseased side were correlated using Spearman's correlation formula and the correlation was found to be significant [rho= -0.690, p=0.000(<0.001)]. The more severe the DNS, the less was the olfactory composite score.

The preoperative visibility of olfactory cleft and preoperative combined olfactory scores of diseased side were correlated using Mann Whitney test and the correlation was found to be insignificant [p=0.134(<0.001)]. There was no relation found between them.

The preoperative presence of posterior septal deviation and preoperative combined olfactory scores of diseased side were correlated using Mann Whitney test and the correlation was found to be insignificant [p=0.042(<0.001)]. There was no relation found between them.

All patients underwent septal correction surgery under local anaesthesia. Patients were followed up as per standard protocol and then repeat observations were recorded after four weeks from the date of surgery.

The preoperative mean score of SFNQ (16.20±3.494) was correlated with postoperative mean score of SFNQ (7.78±3.848) which was found to be statistically significant [p=0.000(<0.001)]. There was decrease in the symptoms assessed on SNFQ after 4 weeks of follow-up.

The preoperative mean score of Visual analogue score (3.27±0.633) was correlated with postoperative mean score of Visual analogue score (1.56±0.709) which was found to be statistically significant [p=0.000(<0.001)]. There was decrease in Visual analogue score after 4 weeks of follow-up, indicating improvement in the sense of smell of patients.

The preoperative mean score of composite olfactory score (7.90±2.234) on the diseased side (where the deviation is present) was correlated with the postoperative mean score of composite olfactory score (12.39±3.687) on the diseased side, which was found to be statistically significant [p=0.000(<0.001)]. There was increase in the composite olfactory score after 4 weeks of follow-up.

The Post operative Rhinomanometry values at 150 Pascal, after 1 month was as follows-

Table 2: Mean Nasal airway flow (NAF) in cm3/sec

	During inspiration(NAF)	During expiration (NAF)
Diseased side	300.37±143.652	352.05±164.484
Non diseased side	384.85±108.578	418.12±132.130

The preoperative mean score of Nasal airway flow (NAF) during inspiration (219.24±87.296) on diseased side was correlated with postoperative mean score of NAF during inspiration (300.37±143.652) on diseased side using T-Test and the improvement was found to be statistically significant [p=0.000(<0.001)].

The preoperative mean score of NAF during expiration (252.40±84.986) on diseased side was correlated with postoperative mean score of NAF during expiration (352.05±164.484) on diseased side using-Test and the improvement was found to be statistically significant [p=0.000(<0.001)]. There was increase in Nasal airway flow (NAF) during inspiration as well as expiration on diseased side after 4 weeks of follow-up.

On detailed statistical analysis of various parameters it was found that; the preoperative VAS score (3.27±0.633) and preoperative composite olfactory scores (7.90±2.234) of diseased side were correlated using Spearman's correlation formula and the correlation was found to be statistically significant [rho= -0.493, p=0.001(<0.001)]. This implies that the objective olfaction test correlated with the subjective sense of smell.

The postoperative VAS score (1.56±0.709) and postoperative composite olfactory scores (12.39±3.687) of diseased side was found to be statistically significant [rho= -0.713, p=0.000(<0.001)]. This implies that after septal surgery, the subjective sense of smell improved and the composite olfactory score also improved on the diseased side.

The preoperative SFNQ (16.20±3.494) scores and preoperative composite olfactory scores (7.90±2.234) of diseased side was found to be significant [rho= -0.436, p=0.004(<0.005)]. This implies that increased score of SFNQ indicating more symptoms was associated with decreased composite olfactory scores.

The postoperative SFNQ scores (7.78±3.848) and postoperative composite olfactory scores (12.39±3.687) of diseased side, and the correlation was found to be significant [rho= -0.497, p=0.001(<0.001)]. This implies that decreased score of SFNQ was associated with increased composite olfactory scores. After surgery the symptoms decreased and composite olfactory score improved.

The preoperative rhinomanometry nasal air flow scores (219.24±87.296) during inspiration and preoperative composite olfactory scores (7.90±2.234) of diseased side were correlated and the correlation was found to be significant [rho= 0.440, p=0.004(<0.005)].

The preoperative rhinomanometry nasal air flow scores (252.40±84.986) during expiration and preoperative composite olfactory scores (7.90±2.234) of diseased side, the correlation was found to be significant [rho= 0.512, p=0.001(<0.001)].

The postoperative rhinomanometry nasal air flow scores (300.37±143.652) during inspiration and postoperative composite olfactory scores (12.39±3.687) of diseased side, the correlation was found to be significant [rho= 0.739, p=0.000(<0.005)].

The postoperative rhinomanometry nasal air flow scores (352.05±164.484) during expiration and postoperative combined olfactory scores (12.39±3.687) of diseased side, the correlation was found to be significant [rho= 0.771, p=0.000(<0.001)].

Discussion

Loss of olfactory function is frequent. Several olfactory tests were introduced during the past 2 decades, but only a few of them proved successful including the university of Pennsylvania smell identification test (UPSIT) and a new olfactory test developed by Kobal and Hummel, which was recently commercially

available under the name “Sniffing sticks”. The structure of the nasal cavity determines the pattern of airflow through the human nose. This pattern, in turn, affects the supply of odorant molecules to the olfactory cleft. Not surprisingly, conditions that impair this air flow, such as a deviated septum, nasal inflammation, congestion or polyps, may have significant effects on olfactory perception, as shown in recent clinical studies.13

At present, Rhinoplasty is the surgical method of choice for many clinicians correcting deviated nasal septum. Postoperatively by using active anterior rhinomanometry, increased nasal airflow was measured.

Of the 100 patients, the primary surgical procedure of 63 patients was septoplasty; of 24, septorhinoplasty; of 3, turbinate resection; and of 10, polypectomy. They found improved olfactory function following septoplasty.

Using an olfactory threshold test and rhinomanometry, Kittel and waller16 measured both a decreased nasal resistance and an improved olfactory ability in 100% of their septal surgery patients.

Using anterior rhinoscopy, Schneider and Wolf made repeated estimates over a period of the degree of nasal airway obstruction in eight subjects. By correlating these estimates of nasal anatomy against the olfactory threshold test results, these investigators found that as airway obstruction increased, olfactory ability decreased.38

Damm et al. (2003) in their study on septoplasty in combination with partial turbinectomy found improvement of odor identification in 80%, odor discrimination in 80%, and odor threshold in 54%, respectively. They concluded that “this type of surgery has a significant effect on olfaction.”

Damm et al. (2002)7 assessed the intranasal volume and its relation to olfactory function in normosomic subjects using MRI scans.

Demole (1967)1 observed preoperative difference of odor thresholds between obstructed and non obstructed sides may relate to patterns of airflow in the nasal cavity, although this relation would need to be substantiated in future experiments.

O Pfaar (2004)11 in his study, Assessment of olfactory function after septoplasty observed no significant change of odor thresholds and odor identification function during the 9 month postoperative follow up.

Micheal Damm (2002)7 in his data suggested that odor thresholds are affected by inter-individual differences in volumes of the inferior meatus remote from the olfactory cleft. It helps to explain results from previous studies showing that postoperative olfactory function7 is changed by surgery which alters spaces in the inferior meatus (e.g. septoplasty, partial inferior resection of turbinates).

Hornung and Leopold6 reported numerous and complex interactions between different volumes of the nasal cavity, indicating that `the relationship between olfactory ability and nasal structure is complex and that changing a structure in one part of the nose far removed from the olfactory area can have dramatic effects on olfactory ability.

Among the various techniques of objective assessment available to evaluate nasal airway flow and nasal airway resistance, Rhinomanometry assesses nasal patency by establishing aerodynamic parameter such as transnasal pressure and flow and is useful in providing a functional assessment. The standardization committee for objective assessment of nasal airway decided that Active Anterior Rhinomanometry (AAR) should be the method of choice for measuring nasal ventilation. Besides being the most physiological method AAR is especially important because information on both nasal cavities can be obtained separately.38

It is generally agreed that rhinomanometry with synchronous recording of flow rate and pressure drop across the nasal cavity during spontaneous breathing is preferable and most reliable method for measuring nasal patency.11

The main aims and objectives of our study were to study the subjective and objective assessment of olfactory function in patients with deviated nasal septum undergoing septoplasty. As earlier studies our study also found improved olfactory

function following septoplasty mainly because of increased nasal airflow caused by correction of deviated nasal septum.

Conclusion

Preoperatively, there was low composite olfactory score on the deviated nasal septum side. Following septoplasty bilateral improvement of olfactory function was seen in 29 patients (70.6%); no change was seen in 5 patients (20.1%); and reduced olfactory function in 3 patients (7.3%) on the affected side. Subjective assessments of preoperative and postoperative olfactory acuity with respective composite olfactory scores did correlate with the results of objective testing. Objective assessments of preoperative and postoperative nasal airflow measured active rhinomanometry did correlate with the respective composite olfactory scores; showing decreased airflow was associated with low composite olfactory score and vice versa.

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