ORIGINAL ARTICLE

Estimation of Nasal and Oronasal Spirometry in Deviated Nasal Septum and Obstructive Sleep Apnea

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Abstract:

Background: Deviated Nasal Septum (DNS) and Obstructive Sleep Apnea (OSA) makes breathing difficult. If it is not appropriately treated, it may result in defective cognition, work performance may worsen and diminution in health-related quality of life. *Aim and Objectives:* To find out the significant difference between oronasal and nasal spirometry among DNS and OSA individuals. *Material and Methods:* Total participants were divided into three groups: Group 1: control, Group 2: DNS and Group 3: OSA. Each group consisted of 150 participants. Two sets of measurements were obtained from each subject i.e. oronasal and nasal spirometry methods. All the data were expressed as mean ± standard error. The means were analysed by One-way Analysis of Variance (ANOVA) with multiple comparison test of Student Newman Keul's test. *Results:* For eight parameters except for Forced Expiratory Volume in 1 second (FEV1%) and Forced Expiratory Time (FET), Oronasal (O) spirometry vs Nasal (N) spirometry were significantly different with nasal values being less than oronasal values. For the same eight parameters, in both DNS and OSA groups, the following results were found. (i) O values were less than that for control groups. (ii) N values were less than that for control groups. (iii) In both experimental groups, nasal spirometry values were less than oronasal spirometry values. *Conclusion:* Nasal FET was increased in both OSA and DNS than oronasal FET. Since it is a simple procedure and does not involve any radiological and endoscopy procedure, FET could be an ideal method for assessing nose nasopharyngeal obstruction.

Keywords: Nasal Septum, Sleep Apnea, Nasal, Oronasal, Spirometry

Introduction:

The nasal septum divides the nasal cavity into the right and left halves. The term Deviated Nasal Septum (DNS) is used to indicate a nasal septum which is not in the midline. The nasal septum has a framework of bone and cartilage lined on either side by nasal epithelium and underlying connective tissue with its rich vascular and nerve supply. It is estimated that in 80% of people, the nasal septum is not exactly in the midline still only in a few of them deviation is severe enough to cause nasal obstruction [1].

DNS makes breathing difficult because one nasal cavity is smaller than the other one. This may be present either from the birth, develop during growth or may be caused by injury to the nose or face. In most cases, DNS is asymptomatic; when symptomatic, the person may have nasal obstruction, nose bleeding, and snoring, facial pain or sleep apnoea. A person with mild DNS has symptoms only at the time of cold, during which the respiratory infection triggers nasal inflammation that temporarily amplifies airflow problems

related to a deviated septum. Once the cold resolves and the nasal inflammation subsides, symptoms also disappear. DNS plays a crucial role in functional nasal breathing, symptoms of nasal obstruction, amplified nasal resistance and occasionally in snoring [2]. A large number of systems for classification of DNS have evolved and the newer ones are reaching wider acceptability [3].

Generally, DNS can be diagnosed (i) anatomically, (ii) by using pressure differences or (iii) with airflow studies. Acoustic Rhinometry (AR) shows up the anatomical features. Rhinomanometry (RMM) is based on pressure measurement in different areas of nasal passage and Nasal Spectral Sound Analysis (NSSD) measures the character of nasal sound [4]. Spirometry and nasal spirometry involve measurement of airflows. Nasal spirometry assesses septal deviation based on Nasal Partitioning of airflow Ratio (NPR). NPR is an essential ratio for measuring the subjects with nasal obstruction [5-6]. Spirometry can be used as an objective tool for assessing nasal patency [7]. Few researchers had done a study on conventional spirometric parameters in septal deviated individuals. Improvement in pulmonary function could be seen well after septoplasty, particularly in Forced Inspiratory Flow (FIF50%) and Peak Expiratory Flow (PEF) values.

OSA affects 2-4% of the adult population with the highest prevalence in middle-aged men and overweight individuals. OSA occurs during sleep with consequent cessation or reduction of the airflow by repetitive episodes of the complete or partial collapse of the upper airway [8]. It causes progressive asphyxia which stimulates the breathing effort more and more until the person is aroused. Untreated OSA is a major decisive factor for cardiovascular morbidity and mortality [9-10]. 80% of individuals with OSA have a daytime sleepiness problem. As the disorder progresses, this sleepiness is associated with a higher risk of impairment in doing regular work and it also sometimes leads to road accidents [11]. Many OSA individuals start developing cognitive and neurobehavioral dysfunction, amnesia, inability to concentrate, irritability and depression [12]. The most common signs and symptoms in adults are snoring, excessive daytime sleepiness and hypertension [13]. If it is not treated properly, it may result in defective cognition, work performance may worsen and diminution in health-related quality of life. Hypertension is the secondary cause of OSA and may contribute to insulin resistance, diabetes, and dyslipidemia [14]. Smoking and drinking alcohol can also be risk factors for OSA.

Clinicians diagnose sleep apnoea based on medical and family history, physical examination and sleep study results. Polysomnogram (PSM) is the most common sleep study for diagnosing sleep apnoea. It records brain activity, eye movements, heart rate and blood pressure. It also records the amount of oxygen in the blood, air movement through the nose, snoring, and chest movements [15-16]. OSA can be graded by calculating Apnoea/Hypoapnea index. It is represented by the number of apnoea and hypoapnea events per hour of sleep. The apnoea must last for about 10 seconds and be associated with decreased blood oxygenation [17]. Most of the previous studies were carried out among DNS and sleep apnea by normal spirometry and limited studies were also available. There is no study available in literature on nasal spirometry. So

the main aim of this study was to find out the significant difference between oronasal and nasal spirometry among DNS and OSA individuals.

Material and Methods:

Two sets of measurements were obtained from each subject. (1) In Oronasal (O) spirometry, a mask was placed over the nose and mouth and measurements done. (2) In the same subject, a smaller mask was placed over the nose and the measurement repeated with the mouth closed so that the person breathes only through the nose. This is called Nasal (N) spirometry since airflow is through the nasopharynx and nose.

Study Participants:

The present study was carried out in Saveetha Dental College and Hospital, Saveetha University and Nithra Institute of Sleep Science, Anna Nagar, Chennai, India during the period from 1st March 2015 to 31st October 2017. Total participants were divided into three groups: Group 1: Control, Group 2: DNS and Group 3: OSA. Each group consisted of 150 participants. The participants were in the age of 25 to 50 of both sexes.

Instrument:

Spirometer:

RMS Helios 401 Spirometer, an electronic, handheld device with the computerised programme was used to assess lung function parameters. The subject breathes into a flow meter which is protected by a bacterial filter. Helios 401 uses an innovative digital turbine to produce precise inspiratory and expiratory measurements at a range from low to high rates. The turbine is detachable and easy to disinfect. For this study, two masks were used in turn, one covering the mouth and nose and the other covering the nose only. During measurement, the appropriate mask was connected to the breathing tube of the instrument. The instrument records several parameters digitally in variable seconds and as percentages besides providing a computer recorded tracing. Some of the commonly used parameters are Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV_1), FEV_1/FVC%, Forced Expiratory Time (FET), Peak Expiratory Flow Rate (PEFR), Forced Inspiratory Flow in 50% (FIF50%), Forced Expiratory Flow in 50%(FEF50%), Peak Inspiratory Flow (PIFR) and Forced Inspiratory Flow Capacity (FIVC).

Oronasal(O) Spirometry:

Instead of using mouth piece as in conventional method, a face mask (No: 4/5 for adults and No.3 for children) which covered both mouth and nose and fitted comfortably was selected for each participant. The subject was asked to practice normal and maximal breathing with the mask under supervision before the actual measurement. During measurement, the subject was asked to keep the mouth open all the time, breathe normally twice, then breathe out maximally and follow it with a maximum inspiration. Each subject was asked to complete three trials and the best one was selected for the study. At least 2-3min rest was given between two successive trials.

Nasal (N) Spirometry:

Before starting the measurement, Otrivine Nasal Spray (Xylometazoline Hydrochloride 0.1% w/v, Zyma Healthcare, Brentford, UK) was used as a standard nasal decongestant. This was administered to the subject at a dose of 2 sprays (0.3 ml) to each nostril. A period of twenty minutes was then allowed for nasal decongestion to occur before

measurement. Each subject held the mask (no: 3 or 2) tightly on the nose and was instructed to close his/her mouth firmly. During nasal spirometry, if mouth leakage was either reported by the subject or noticed by the research team, the test was discarded and repeated all over again. Measurement procedure was the same as for oronasal method.

Sample Size and Sampling Technique:

For the comparison and to find the differences among male and female of the respiratory parameters between oral and nasal, assuming 10% difference among the mean with 25% of SD, 90% power and 5% of significance level, the estimated sample size was 133. Adding 10% drop out the sample size was rounded off to 150 for oral and nasal spirometry. Sigma Stat software was used for estimating sample size.

Inclusion and Exclusion Criteria:

Common cold, adenoids, allergic rhinitis, acute upper respiratory tract infection at the time of examination, congenital facial anomalies, lower airway diseases and those who could not cooperate were excluded from this study. Participants those whose polysomnography reports were compatible with moderate or severe OSA were included in this study. Based on medical history and endoscopic examination the cases of DNS were selected and were included in this study.

Data Collection:

This study was approved by the Institutional Human Ethical Committee (Ref: IHEC no: 015/01/2015/IE/SU) of SMHC. Before starting the procedure, a detailed explanation of the test protocol was given to the participants and informed consent was also acquired. Both the measurements were examined for all participants.

Statistical Analysis:

All the data were expressed as mean ± Standard Error (SE). The means were analysed by One-Way Analysis of Variance (ANOVA) with multiple comparison test of Student Newman Keuls test. Statistical analysis as well as the plotting of graphs, was carried out using SigmaPlot 13.0. $P < 0.05$ was considered as significant.

Results:

The spirometric parameters FVC, FEV_1, FEV_1/FVC, PEFR, FEF 25-75%, FEF50%, FIVC, PIFR, FIF50%, FET for control, DNS and OSA groups were measured (Fig.1). Statistical significance calculated between O vs N mean values in all groups for each parameter. For each parameter, the nasal/oronasal ratio was calculated and the statistical difference calculated between the control, DNS and OSA groups.

For eight parameters except for FEV1% and FET, O vs N was significantly different with nasal values being less than oronasal values. For the same eight parameters, in both DNS and OSA groups, the following similarities were found. (I) O spirometry values were less than that for control groups. (ii) N spirometry values were less than that for control groups. (iii) In both experimental groups, nasal spirometry values were less than oronasal spirometry values

Regarding comparison with DNS and OSA for these eight parameters, the results were mixed. Significant increase in DNS values was seen in both O and N, FVC in males and females, O-FEV_1 in males, O-FEF 25-75% in males (Fig. 2), O-FEF 50% in males (Fig. 3), O- and N-FIVC in females and O-PIFR in females. Significant increase for OSA was found in O-PEFR and N-PEFR in females, O-PIFR in males and O-FIF in males.

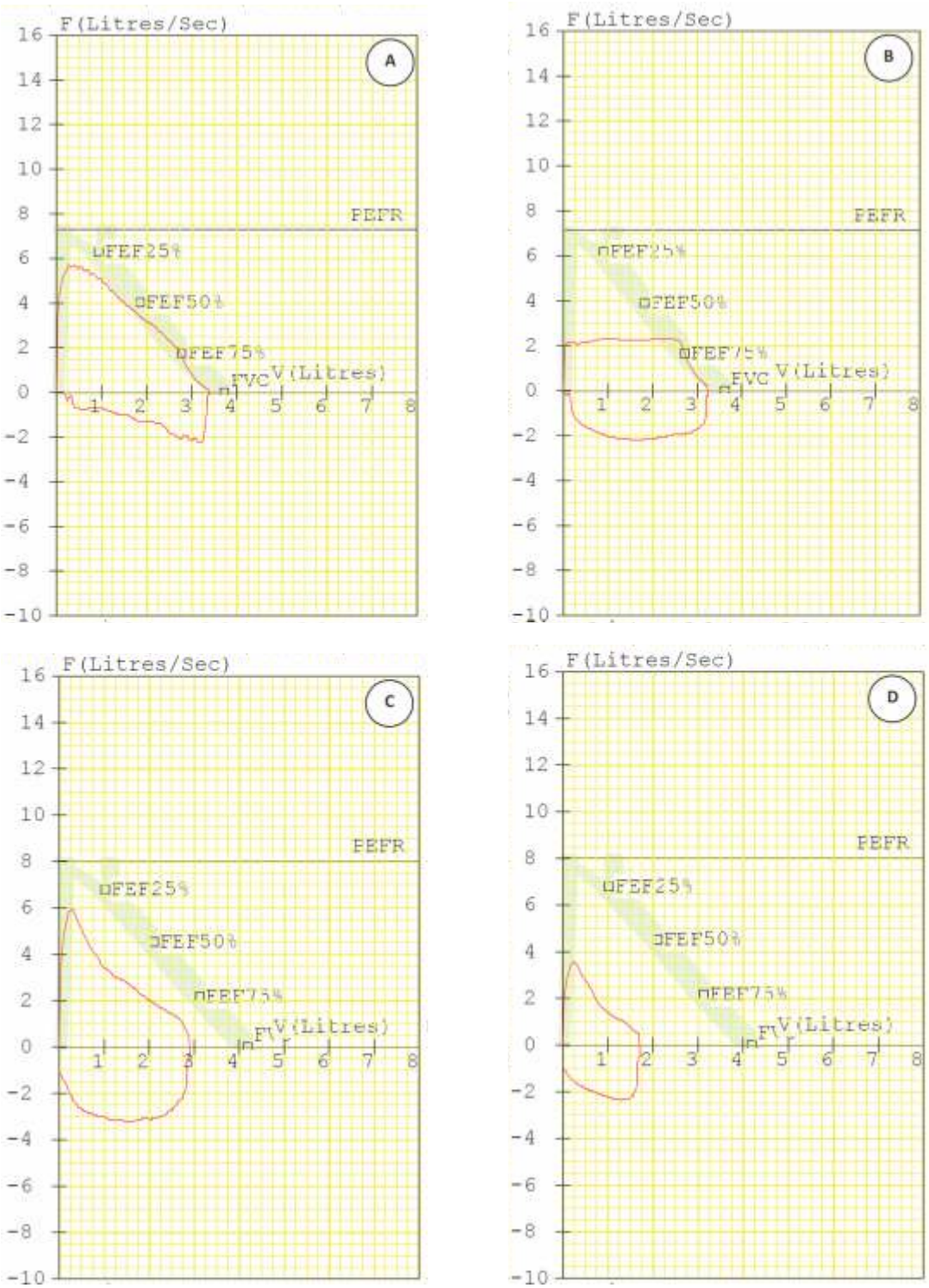

Fig. 1: Flow Volume Loop of Oronasal (A) and Nasal (B) Spirometry for OSA Individuals and Flow Volume Loop of Oronasal (C) and Nasal (D) Spirometry for DNS Individuals

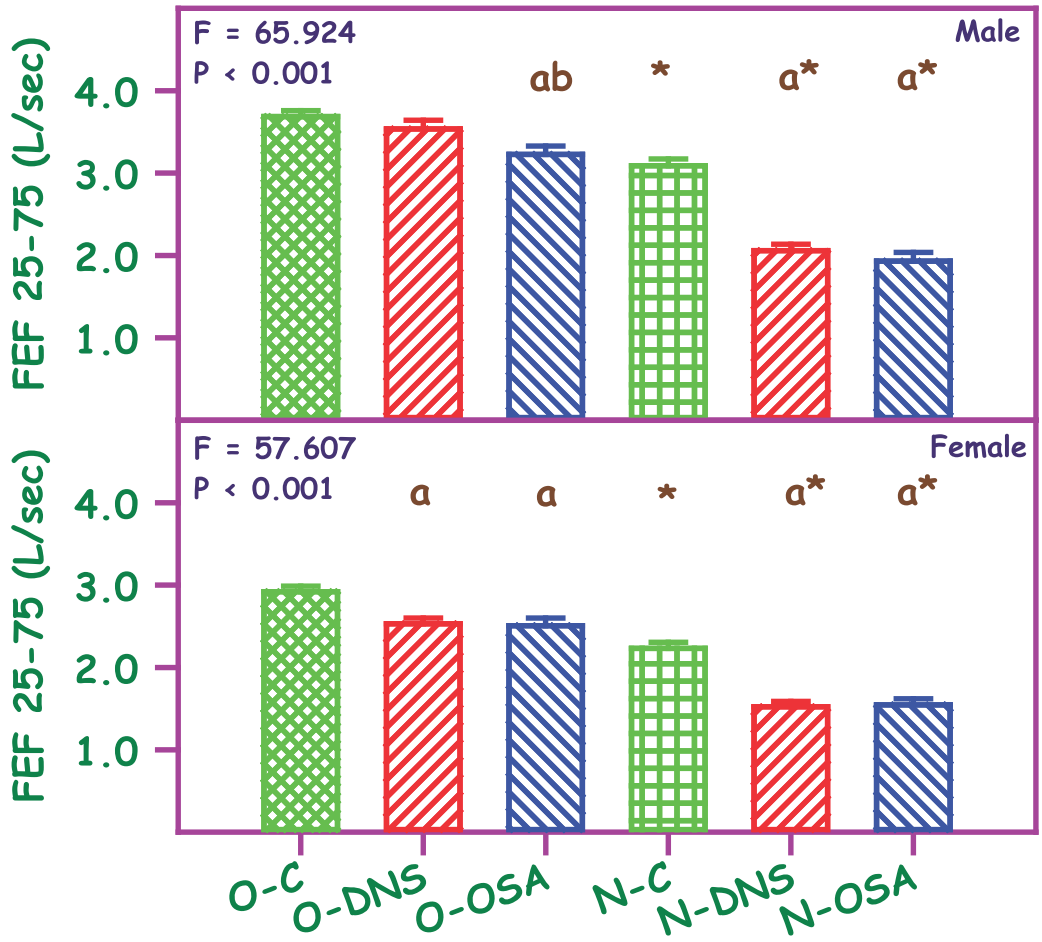

Fig. 2: Comparison of FEF 25-75% in Oronasal (O) and Nasal (N) Spirometry of Control (C), Deviated Nasal Septum (DNS) and Obstructive Sleep Apnoea (OSA) groups.

*[a]Significantly different from the respective control group, [b]Significantly different from the respective DNS group, *Significantly different from the respective oral group*

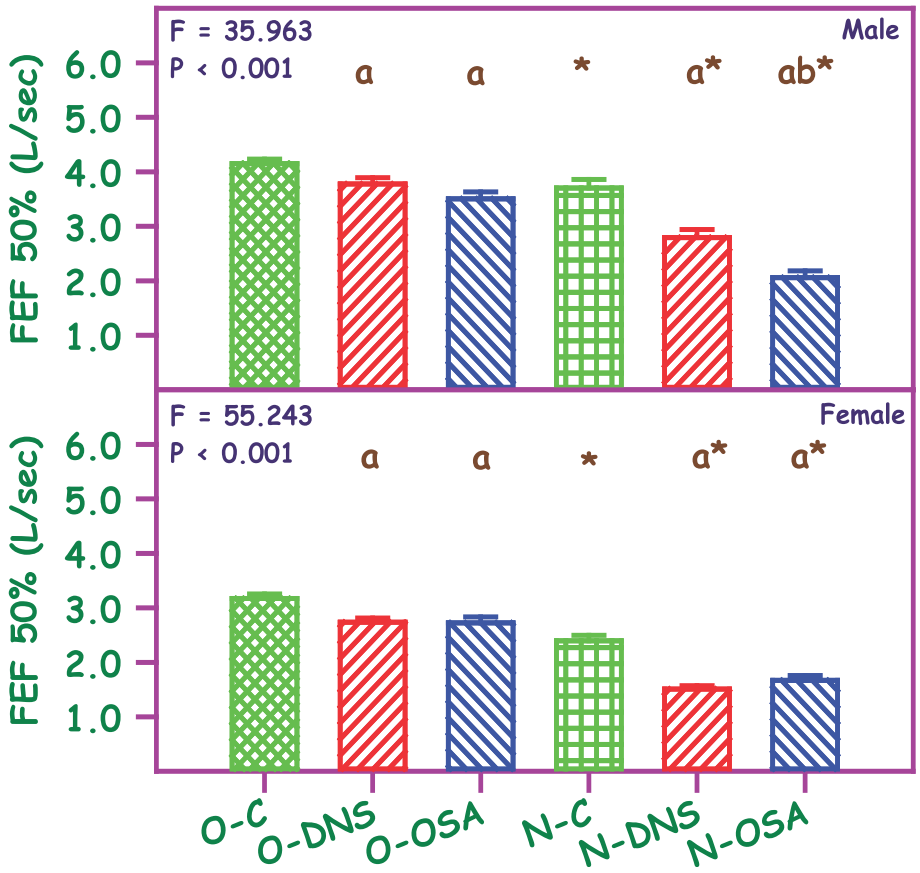

Fig. 3: Comparison of FEF 50% in Oronasal (O) and Nasal (N) Spirometry of Control (C), Deviated Nasal Septum (DNS) and Obstructive Sleep Apnoea (OSA) Groups

*[a]Significantly different from the respective control group, [b]Significantly different from the respective DNS group, *Significantly different from the respective oral group.*

For FEV_1% in DNS and OSA groups, O vs N was not significantly different in controls. In both OSA and DNS groups, there was no significant difference in oral spirometry values when compared to controls in both sexes. Again in both sexes, nasal spirometry values were significantly less than that of controls and O vs N was significantly less within the two groups. Comparing DNS and OSA groups, OSA values were higher than the DNS values. The increase was significant for O-FEV_1% in females and N-FEV_1% for both sexes.

For FET in DNS and OSA groups, O vs N was not significantly different in controls. Oral FET was not significantly different from control FET except in DNS males. Both DNS and OSA groups had significantly higher nasal FET vales (i) when compared to controls and (II) in O vs N within the group (Fig. 4).

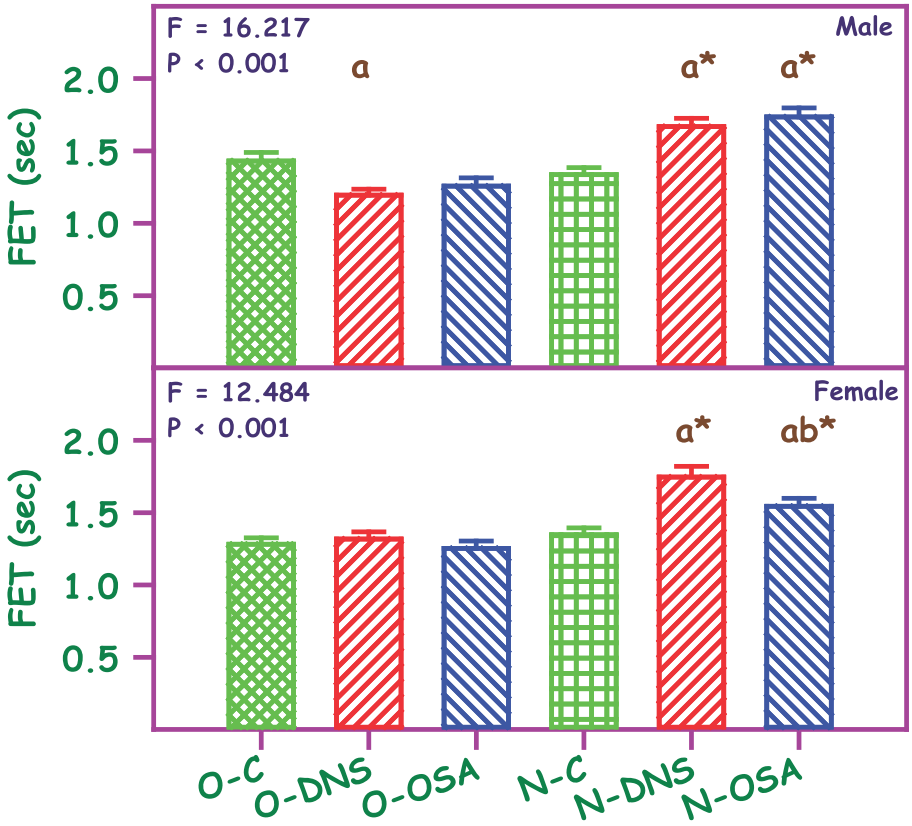

Fig. 4: Comparison of FET in Oronasal (O) and Nasal (N) Spirometry of Control (C), Deviated Nasal Septum (DNS) and Obstructive Sleep Apnoea (OSA) Groups

*[a]Significantly different from the respective control group, [b]Significantly different from the respective DNS group, *Significantly different from the respective oral group.*

Discussion:

DNS or OSA alters the respiratory mechanics and these variations can affect normal pulmonary airflow. Narrowing of the nasal passage by DNS or OSA leads to obstruction in the nose-nasopharynx region. This obstruction can also reduce lung compliance and increase airway resistance.

The pattern of obstruction was similar in both DNS and OSA and was different from that of adenoids. Except FEV_1% and FET, other parameters of oronasal and nasal flow values were significantly less than control values in both sexes. When oronasal flow rates were compared to nasal flow rates in control, DNS and OSA groups, nasal values were significantly less than oronasal values. These results showed that normal differences between oronasal and nasal spirometry are maintained in people with DNS and OSA too, but since their oronasal values are lower than normal, nasal spirometry flow values are considerably reduced.

Flow volume loop and spirometric indices FVC, FEV_1%, FIF50%, FEF50%, PEFR were studied in people with OSA andno significant difference was found [18-19]. In other studies, after treatment with Continuous Positive Airways Pressure (CPAP) for OSA, the decline in FEV_1 was observed [20]. FVC,

FEV_1 and FEV_1% were found significantly lower in severe OSA individuals [21]. No significant change of FEV_1, FEV_1% and FEF25-75% was found in OSA by Ozturk *et al.*, 2005 [22].

These results are in contrast to the oronasal values of the current study, which is comparable to oral spirometry; where FVC, FIF50%, FEF50% and PEFR values were significantly less than that for controls. Oronasal FEV_1% did not show any significant difference between controls and experimental subjects. Another study found that FEV_1% was slightly higher in OSA than healthy individuals [23]. Nasal spirometry is shown to be clearly superior to oral studies and clearly demonstrated reduction in all the eight parameters mentioned above.

One reason for the reduction in oronasal flows especially in OSA could be increased pharyngeal airway resistance. Males have greater pharyngeal airway resistance than females [24]. Females have greater stability and less dependence on lung volume; this also may act as an important role than pharyngeal size. In OSA, it is likely that pharyngeal size is decreased some more. During expiration, most of the OSA individuals have increased airway resistance [25].

The main reason for the reduction in nasal airflow in the deviated nasal septum is likely to be the increased nasal airflow resistance resulting from the narrowed nasal passage. This may directly or indirectly affect pulmonary function. A few studies of spirometry on people with DNS before and after surgery found some significant change in few parameters. PEF and FIF50 increased significantly after septoplasty [26]. FVC, FEV_1, PEFR also showed significant difference after septoplasty [27]. In the present study, nasal PEFR was reduced more in DNS than OSA when compared to oronasal PEFR in both sexes.

During inspiration, negative suction pressure develops thereby it causes distortion of upper airway [28]. During inspiration, the major cause of reduced airflow is narrowing of airway secondary to high extraluminal pressures than intraluminal pressures. Nasal Inspiratory Peak Flow (NIPF) can be used as an alternative source for determining nasal patency in case of obstruction or inflammation [29].

In the present study, oronasal FET was significantly more than control values only in the case of males with DNS. In both sexes, both DNS and OSA groups had higher nasal FET when compared to controls and also when compared to oronasal FET. In females, the nasal FET value was significantly less in OSA than in DNS. The nasal/oronasal ratio for FET was also significantly more than controls in both male and female OSA and DNS subjects.

Conclusion:

Nasal FET was increased in both OSA and DNS than oronasal FET. Since it is a simple procedure and does not involve any radiological and endoscopy procedure, FET could be an ideal method for assessing nose nasopharyngeal obstruction.

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