ECRONICON OPEN ACCESS

EC PULMONOLOGY AND RESPIRATORY MEDICINE

Research Article

Should We Perform Spirometry and Arterial Blood Gas Analyses in Evaluating Obstructive Sleep Apnea Syndrome?

Elif Torun Parmaksız[1]*, Banu Salepçi[2], Ali Fidan[1], Gülten Aktın Güngör[3], Esma Coşkun[3] and Benan Çağlayan[4]

[1]University of Health Sciences, Kartal Dr Lutfi Kirdar Training Hospital, Chest Diseases, Istanbul, Turkey

[2]Assistant Professor, Yeditepe University, Faculty of Medicine, Chest Diseases, Istanbul, Turkey

[3]Nurse, University of Health Sciences, Kartal Dr Lutfi Kirdar Training Hospital, Chest Diseases, Istanbul, Turkey

[4]Professor, Koç University, Faculty of Medicine, Chest Diseases, Istanbul, Turkey

***Corresponding Author:** Elif Torun Parmaksız, University of Health Sciences, Kartal Dr Lutfi Kirdar Training Hospital, Chest Diseases, Istanbul, Turkey.

Received: August 10, 2017; **Published:** January 29, 2018

Abstract

Study Objective: Spirometry is an important tool for the assessment of lung functions and represente the cornerstone diagnostic tool for obstructive and restrictive lung diseases. The aim of this study is to evaluate lung functions based on arterial blood gases (ABG) measurement and spirometry.

Methods: The files of 784 subjects referred for polysomnography (PSG) to our sleep laboratory between January 2013-July 2015 were retrospectively evaluated.

Results: In the whole group, 99 subjects had restrictive dysfunction and 66 subjects had obstructive disease. Among OSAS cases, 95 had restrictive and 60 had obstructive pathology. Only 26 subjects had previously diagnosed lung function impairment. The FEV1(%), FEV1/FVC, FEF25-75(L/s) ve FEF25-75(%) were found to be significantly declined in subjects OSAS compared to non-OSAS group. FVC%, FEV1%, FEV1/FVC, FEF25-75(L/s) and FEF25-75% got significantly lower as the disease got more severe. Among OSAS subjects, as the disease progressed, PaO_2 and spO_2 decreased and $PaCO_2$ increased significantly.

Conclusion: Our study revealed a clear relationship between lung function impairment and OSAS. Both obstructive and restrictive lung dysfunction may be associated with OSAS. A regular inquiry of OSAS patients about respiratory capacity and implication of pulmonary function tests may help diagnosing coexisting lung dysfunction and helps management of the disease accordingly.

Keywords: *Spirometry; Arterial Blood Gas; Obstructive Sleep Apnea Syndrome (OSAS)*

Introduction

Obstructive sleep apnea syndrome (OSAS) is a highly prevalant disease characterized by respiratory disturbences, namely apneas and hypopneas during sleeep. Currently, OSAS is considered as a component of metabolic syndrome, and is thought to be associated with hypertension, cardiovascular diseases, diabetes, atherosclerosis and cerebrovascular events [1-3]. The common denominator in majority of these diseases is obesity. Co-existance of OSAS and lung function impairment is also becoming increasingly recognized [4-6]. Both diseases are associated with low-exercise tolerance and reduced quality of life due to ventilatory disturbances.

Obstructive sleep apnea syndrome (OSAS) is a highly prevalant disease characterized by respiratory disturbences, namely apneas and hypopneas during sleeep. Currently, OSAS is considered as a component of metabolic syndrome, and is thought to be associated with hypertension, cardiovascular diseases, diabetes, atherosclerosis and cerebrovascular events [1-3]. The common denominator in majority of these diseases is obesity. Co-existance of OSAS and lung function impairment is also becoming increasingly recognized [4-6]. Both diseases are associated with low-exercise tolerance and reduced quality of life due to ventilatory disturbances.

Spirometry is a common clinical tool for measuring lung volumes and the extent of airflow limitation. It is an important tool for the assessment of lung functions and represents the cornerstone diagnostic tool for obstructive and restrictive lung diseases. Another tool helpful in the assessment of lung functions is arterial blood gases (ABG) measurement. The analysis of ABG is an essential part of diagnosing the oxygenation and hypoventilation status. When combined with spirometry, these data enable us to make a much easier interpretation on functional respiratory status.

We aimed to determine pulmonary function measurements and oxygen and carbondioxide measurements during wakefulness in OSAS patients and thereby to characterize the association between lung functions and OSAS severity.

Material and Method

The study population consisted of subjects referred for polysomnography (PSG) to our sleep laboratory between January 2013-July 2015. The patient files were retrospectively evaluated. Subjects who had undergone spirometric analysis and ABG measurements were included in the study.

The presenting symptoms were one or more of the following: habitual snoring, witnessed apnea, excessive daytime sleepiness and unsatisfactory sleep. All subjects underwent detailed physical examination including pulmonary, cardiological and neurological, as well as ear-nose-throat examinations. Laboratory evaluations, including complete blood count, biochemical tests were performed. Arterial blood gas measurements were made. Patients were evaluated with spirometry and chest radiographs on the morning following PSG.

All cases had undergone overnight polysomnography with computerized PSG systems (Comet Grass, Astro-Med, Inc., West Warwick, RI, USA and Viasys Cephalo Pro,SomnoStar, VIASYS Healthcare, Hoechberg, Germany). We monitored and recorded all night electroencephalography (EEG), electrooculography (EOG), electrocardiography (ECG), chin and tibial electromyography (EMG), respiration, rib-cage and abdominal movements, snoring, body position and oxygen saturation by finger pulse oxymetry. The digitized EEG records were scored in 30-second epochs according to standardized criteria and respiration was scored by certified specialists according to AASM 2012 [7] criteria. Apnea-hypopnea index (AHI) was calculated as the sum of apneas and hypopneas during the sleep period divided by total sleep time. We defined apnea as a cessation of air flow for more than 10 seconds and hypopnea as a reduction of air flow > 50% for > 10 seconds plus oxygen desaturation of > 3% or arousal. Arousals were scored as an abrupt shift of EEG frequency lasting at least 3 seconds, with at least 10 seconds of preceding stable sleep. Arousal index was calculated as number of arousals per hour of sleep.

All cases had pulmonary function tests performed according to American Thoracic Society/European Respiratory Society guidelines [8] by the same experienced technician in the morning following sleep study. Each patient received exactly the same instructions.

Forced vital capacity(FVC), forced vital capacity in 1 second (FEV1), FEV1/FVC, forced expiratory flow at 25% (FEF25), 50% (FEF50) and 75% (FEF75) of vital capacity were recrded. Airflow limitation was diagnosed when the ratio of FEV1 to FVC was less than 70% predicted.

The height and weight of each individual were measured and body mass index (BMI) was calculated as weight in kg/height square in m^2.

The arterial blood gas analyses were performed before the recording of PSG started, during wakefulness with the patient in sitting position and breathing room air. Partial pressure of oxygen in arterial blood (PaO_2), partial pressure of carbon dioxide in arterial blood ($PaCO_2$) and pH were measured in a blood gas analyzer.

Statistical Analysis

SPSS 17.0 software was used for data analysis. To compare means between OSAS and nonOSAS groups T-test was used and descriptive statistics were given as mean ± SD. When groups were more than three and distribution was normal, Anova test was used for three OSAS severity groups and descriptive statistics were given as mean ± SD.

Results

The study population consisted of 531 (68%) male and 253 (32%) female patients. The mean age of 784 subjects was 48.7 (± 11,88). Overnight polysomnography revealed that 708 (%90) subjects had AHI > 5; 209 (29.5%) had mild (AHI between 5 - 15), 169 (23.9%) had moderate and 330 (46.6%) had severe OSAS (Figure 1). Study population characteristics and polysomnography results are shown in table 1.

	Mild OSAS (n = 209)	Moderate OSAS (n = 169)	Severe OSAS (n = 330)
Age	46.8 ± 10.9	49.2 ± 11.1	51.26 ± 12.15
BMI	30.43 ± 5.84	30.53 ± 5.11	33.50 ± 6.79
Total sleep time (min)	337	319.53	222.53
Sleep efficiency (%)	82	81	77
Sleep latency (min)	15	19	17
REM latency (min)	128	124	136
Stage 1 (%)	7.03	7.66	11.98
Stage 2 (%)	59.05	59.26	68.05
Stage 3 (%)	18.14	16.55	9.95
REM (%)	15.78	16.60	10.60
AHI	9.38	21.16	61.26
AI	2.71	7.92	42.45
Time of sleep spO_2 < 90 (min)	9.50	6.78	33.55
ODI	7	17	52
Minimum spO_2 (%)	86	83	75
Mean spO_2 (%)	94	93	90
Mean pulse (beat/min)	68	67	71

Table 1: *Polysomnograhic data in mild, moderate and severe OSAS.*

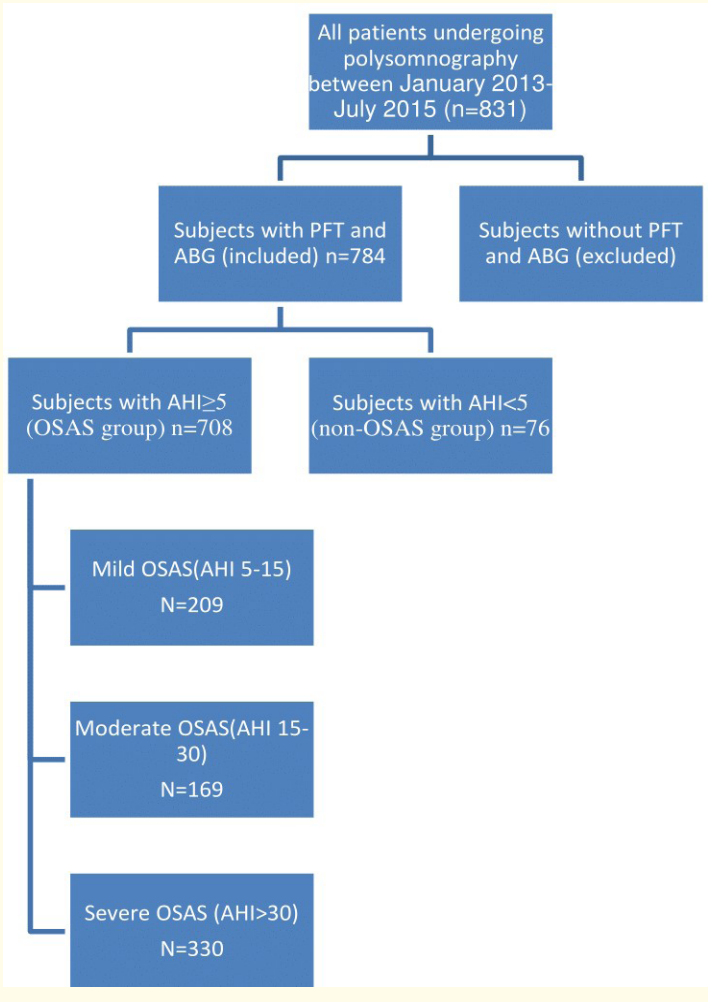

Figure 1: *Distribution of the patients.*

As could be expected, apneic subjects had significantly higher mean BMI compared to nonapneic group (31.8 and 27.9, respectively; $p < 0.0001$). When OSAS group is considered, BMI tended to increase significantly as the severtiy of the disease increased. BMI was 30.43 in the mild group, 30.53 in the moderate group and 33.50 in the severe group ($p < 0.0001$).

Regarding the whole group, spirometry results revealed restrictive dysfunction in 99 subjects and obstructive disease in 66 subjects. Among OSAS cases, 95 had restrictive and 60 had obstructive pathology.

Only 26 subjects had previous diagnosis of a lung disease with functional impairment. This group consisted of subjects with known diagnosis of COPD, asthma or interstitial lung disease.

The FEV1 (%), FEV1/FVC, FEF25-75(L/s) ve FEF25-75 (%) were significantly different among subjects with and without OSAS ($p < 0,0001$ for all parameters). All mentioned parameters were significantly lower in apneic cases. FVC% did not show significant difference ($p = 0,06$). OSAS group had significantly lower PaO_2 and oxygen saturation (spO_2) measurements ($p = 0,004$; $p = 0,002$, respectively) and significantly higher $PaCO_2$ levels ($p = 0,03$) (Table 2).

	Non-OSAS group (n = 76)	OSAS group (n = 708)	
	Mean	Mean	p value
Age	41.5	49.4	< 0.0001**
BMI	27.9	31.8	< 0.0001**
FVC (%)	96.5	91.8	0.06
FEV1 (%)	93.9	72.5	< 0.0001**
FEV1/FVC	81	63	< 0.0001**
FEF25-75 (l/S)	3,12	1,29	< 0.0001**
FEF25-75 (%)	81	34.1	< 0.0001**
Ph	7,43	7,41	0.04*
pO2	87.7	79.1	0.004*
pCO_2	39.3	42.2	0.03*
spO_2	96.0	92.7	0.002*

Table 2: *Measurement of pulmonary functions and arterial blood gases in OSAS and non-OSAS groups.*

Spirometric measurements and ABG results were compared between mild, moderate and severe OSAS groups (Table 3). FVC%, FEV1%, FEV1/FVC, FEF25-75(L/s) and FEF25-75% tended to decrease significantly as the disease got more severe ($p < 0,0001$ for all parameters). Among OSAS subjects, as the disease progressed, PaO_2 and spO_2 decreased and $PaCO_2$ increased significantly ($p = 0,004$, $p = 0,002$ and $p = 0,03$, respectively).

	Mild OSAS (n = 209)	Moderate OSAS (n = 169)	Severe OSAS (n = 330)	p value
FVC %	101	98	90	< 0,0001
FEV1 %	97	91	87	< 0,0001
FEV1/FVC	81	78	78	< 0,0001
FEF25-75(l/S)	3,37	3,15	2,63	< 0,0001
FEF25-75%	85	71	71	< 0,0001
pH	7,43	7,42	7,42	0,17
pO_2	89,22	89,28	84,42	0,009
pCO_2	38,88	38,70	41,25	0,002
spO_2	97	97	96	0,013

Table 3: *Measurement of pulmonary functions and arterial blood gases in mild, moderate and severe OSAS.*

Discussion

This study, carried out on a large number of subjects, presents results of a signicant association between presence and severity of OSAS and lung function impairment. The main findings are:

1. OSAS is associated with lower FEV1(%), FEV1/FVC, FEF25-75(L/s) ve FEF25-75(%) values.
2. OSAS is associated with decreased pO_2 and spO_2 and increased pCO_2 measurements.
3. Regarding mild, moderate and severe subgroups FVC%, FEV1%, FEV1/FVC, FEF25-75(L/s) and FEF25-75% decreased as AHI increased.
4. pO_2 and spO_2 decreased and pCO_2 increased as disease progressed.
5. 5-A substantial number of OSAS cases with no prior lung disease have deteriorated lung functions.

In view of the above-mentioned statistical differences, there is a clear relationship between lung function impairment and OSAS. Several studies have been carried out on the association between lung volume and nocturnal obstructive apneas and desaturations in small study groups and it was found out that lung volumes could have an important role on apnea-induced desaturation and sleep-induced respiratory events [9,10]. Önal., *et al*. demonstrated that decreased pulmonary volume and increased airway resistance contribute to the severity of sleep-induced respiratory abnormalities in OSAS patients [9]. In another study concerning the relationship between lung volumes and decreases in oxygen saturations during sleep, ERV was found to be strongly correlated with the severity of apnea-induced desaturation [10]. In a cross sectional study, lower FVC, not lower FEV1, was significantly associated with higher respiratory disturbance index (RDI). The authors showed a relationship between impairment of lung functions and metabolic syndrome independent of cardiovascular risk factors such as age, obesity and smoking. The association between abdominal obesity and decline in FVC was attributed to both mechanical affects to the diaphragm and chest wall compliance and systemic inflammation [11]. In our analyses, BMI of OSAS patients was significantly higher than nonapneics, however the decline in FVC was not statistically significant, though remarkable. On the other hand, similar to the mentioned study FVC got significantly lower as the severity of the disease increased. What is more, we also showed that FEV1 was also associated with disease severity.

Obstructive lung diseases and OSAS share several common features such as increased work of breathing during sleep, hypoventilation, hypoxemia, hypercapnia and development of pulmonary hypertension. OSAS is associated with nocturnal arterial oxygenation, but it also has significant impact on daytime hypoxemia. Smoking, which is a well known risk factor for lung function impairment, is also associated with OSAS. Gastroesophageal reflux disease and allergic rhinitis are other conditions that increase severity of symptoms in both chronic obstructive pulmonary disease (COPD) and OSAS.

The coexistance of OSAS and COPD is not uncommon and Flenley., *et al*. named this combination as overlap syndrome [12]. Overlap syndrome is associated with upper and lower airway obstruction and reduction in respiratory drive, which result in hypoventilation and desaturation. COPD patients present several features that may contribute to increased prevalence and symptoms of sleep disordered breathing such as increased neck size due to systemic steroids, increased upper airway edema, decreased exercise capacity contributing to obesity and muscle weakness leading to easy upper airway collapsibility. On the other hand, some features of OSAS lead to increased risk of COPD, as well as worsening of COPD symptoms. These include systemic inflammation contributing to lower airway inflammation, ischemia-reperfusion injury and oxidative stress, nasal congestion from PAP therapy, daytime sleepiness and mood disturbances due to poor sleep and worsening of asthmatic component of the disease [13]. Desaturations during sleep seem to be deeper and longer in overlap syndrome. Several machanisms have been postulated on daytime hypoxemia in OSAS and overlap syndrome. These include BMI, sleep desaturations and FEV1 [14].

Sleep has profound effects on ventilation. As a result of significant reduction in minute ventilation during sleep, there is a decrease in PaO_2 and an increase in partial pressure of carbon dioxide in arterial blood ($PaCO_2$). The alteration in gas exchange is more pronounced during REM sleep. The ventilatory response to hypercapnia and hypoxia is also diminished during sleep, with the reduction being more prominent in REM sleep. The majority of OSAS patients have an abnormal pharyngeal structure and function, with episodic complete airway occlusion during sleep. Intermittent hypoxemia, a fundamental pathophysiological consequence of OSAS is also a feature of obstructive and restrictive lung diseases [13].

OSAS brings risk of serious complications. Obesity causes loading of respiratory muscles and increased upper airway resistance, and is associated with blunted chemosensitivity. OSAS, as well as other components of metabolic syndrome is frequently associated with obesity.

One of the most common problems encountered in managing OSAS is convincing the patient for the burdensome treatment. Although noninvasive mechanical ventilation (NIMV) is generally effective in correcting sleep-related respiratory disturbances, intolerance and failure to comply poses a serious limitation to its use. Continuous positive airway pressure (CPAP) is the most widely used treatment of choice, however it has been shown that patients who are more obese and who have awake arterial blood gas anbnormalities are more prone to have failure to CPAP treatment [15]. In COPD, expiration is difficult and uncomfortable when EPAP is high. Resta et al showed that bilevel positive airway pressure (BiPAP) was more effective in subjects with higher BMI, higher pCO2, lower pO2 and sO2, lower FEV/FVC, FEV1 and FVC measurements [16].

BiPAP is preferred in subjects with accompanying airway disease, such as COPD. OHS is another condition where CPAP fails to control hypoventilation and hypercapnia and BiPAP is the preferred treatment of choice to maintain airway patency [16]. Determining a coexisting respiratory dysfunction, enables choosing the optimal NIMV modality for the patient (CPAP, BiPAP, autotitrating PAP) and thereby may enhance compliance with therapy. In our clinical practice, we perform spirometry for all subjects undergoing PSG and start the treatment accordingly.

It is well known that many patients with sleep apnea have intermittent episodes of hypoxemia following apnea or hypopnea periods. The use of supplemental oxygen during sleep can be effective in improving the AHI, respiratory arousal index, and nocturnal desaturation during apneic episodes, however, it lengthens apnea duration and thereby accelerate CO2 retention [17]. Patients with overlap syndrome present more nocturnal desaturation than patients with either OSAS or COPD alone [18]. Determining the optimal indication for oxygen supplementation is one of the major goals of the treatment. This helps reducing the deleterious effects of hypoxemia, as well as preventing the negative effects of oxygen treatment.

The airflow limitation is usually associated to exposure to noxious particles or gases, primarily cigarette smoke. Smoking is a major risk factor for many respiratory diseases including obstructive lung diseases, as well as OSAS. A potential limitaion of our study is that smoking habits of all population could not be reached and other chronic diseases were not recorded. Due to retrospective set-up of the analysis, this study was subject to some data loss. This is a single center study conducted in the Pulmonology department of a multidisciplinary hospital, this may lead to some selection bias.

PSG is the gold standard for establishing OSAS diagnosis and the usefulness of this tool can be enhanced when it is accompanied by other tests Diagnosing a coexisting respiratory dysfunction is mandatory for the physician to manage the sleep problem efficiantly. It helps to guides the treatment plan. Choosing the most appropriate treatment modality, determining the best mode and type of the ventilator and detecting the need for additional equipment such as home O_2 supplies is essential for treating OSAS. These factors not only lead to better prognosis, but also increase the compliance of the patient to that treatment modality.

Conclusion

As a conclusion, OSAS fequently occurs in concurrence with respiratory dysfunction. Both obstructive and restrictive lung dysfunction may be associated with OSAS. A regular inquiry of OSAS patients about respiratory capacity and implication of pulmonary function tests may help diagnosing coexisting lung dysfunction and helps management of the disease and improvement of quality of life.

Financial Support

No financial support for the work.

Conflict of Interest

No conflict of interest for any author.

Bibliography

1. Hamilton GS., *et al*. "Obstructive sleep apnoea and cardiovascular disease". *Internal Medicine Journal* 34.7 (2004): 420-426.
2. Sorajja D., *et al*. "Independent association between obstructive sleep apnea and subclinical coronary artery disease". *Chest* 133.4 (2008): 927-933.
3. Tanno S., *et al*. "Sleep-related intermittent hypoxemia and glucose intolerance: a community-based study". *Sleep Medicine* 15.10 (2014): 1212-1218.
4. Veale D., *et al*. "Mortality of sleep apnoea patients treated by nasal continuous positive airway pressure registered in the ANTADIR observatory". *European Respiratory Journal* 15.2 (2000): 326-331.
5. Kaw R., *et al*. "Determinants of hypercapnia in obese patients with obstructive sleep apnea: a systematic review and metaanalysis of cohort studies". *Chest* 136.3 (2009): 787-796.
6. Chaouat A., *et al*. "Pulmonary hemodynamics in the obstructive sleep apnea syndrome. Results in 220 consecutive patients". *Chest* 109.2 (1996): 380-386.
7. Grig-Damberger M. "The AASM Scoring Manuel Four Years Later". *Journal of Clinical Sleep Medicine* 8.3 (2012): 323-332.
8. Miller MR., *et al*. "Standardisation of spirometry". *European Respiratory Journal* 26.2 (2005): 319-338.
9. Onal E., *et al*. "Relationship between pulmonary function and sleep-induced respiratory abnormalities". *Chest* 87.4 (1985): 437-441.
10. Sériès F., *et al*. "Role of lung volumes in sleep apnoea-related oxygen desaturation". *European Respiratory Journal* 2.1 (1989): 26-30.
11. Yoshimura C., *et al*. "Relationships of decreased lung function with metabolic syndrome and obstructive sleep apnea in Japanese males". *Internal Medicine* 51.17 (2012): 2291-2297.
12. Flenley DC. "Sleep in chronic obstructive lung disease". *Clinics in Chest Medicine* 6.4 (1985): 651-661.
13. Budhiraja R., *et al*. "Sleep disorders in chronic obstructive pulmonary disease: etiology, impact, and management". *Journal of Clinical Sleep Medicine* 11.3 (2015): 259-270.
14. Lacedonia D., *et al*. "Daytime PaO2 in OSAS, COPD and the combination of the two (overlap syndrome)". *Respiratory Medicine* 107.2 (2013): 310-316.
15. Schäfer H., *et al*. "Failure of CPAP therapy in obstructive sleep apnoea syndrome: predictive factors and treatment with bilevel-positive airway pressure". *Respiratory Medicine* 92.2 (1998): 208-215.

16. Resta O., *et al*. "Prescription of nCPAP and nBIPAP in obstructive sleep apnoea syndrome: Italian experience in 105 subjects. A prospective two centre study". *Respiratory Medicine* 92.6 (1998): 820-827.

17. Mehta V., *et al*. "Obstructive sleep apnea and oxygen therapy: a systematic review of the literature and meta-analysis". *Journal of Clinical Sleep Medicine* 9.3 (2013): 271-279.

18. Sanders MH., *et al*. "Sleep and sleep-disordered breathing in adults with predominantly mild obstructive airway disease". *American Journal of Respiratory and Critical Care Medicine* 167.1 (2003): 7-14.

Volume 7 Issue 2 February 2018