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Polysomnography-based diagnosis in Mexican adult patients with Obstructive Sleep Apnea Syndrome (OSAS) clinical suspicion

Edgar Arrazola-Cortés [1], Josefina Hernández-Cervantes [2], Brenda González-Pérez [1], Sergio Sauri-Suárez [3], Luz Berenice López-Hernández [4], Christian Gabriel Toledo-Lozano [4], Vanessa Orellana-Villazón [4], Sofia Lizeth Alcaraz-Estrada [5], Silvia García [6]

1 Department of Neurophysiology, Centro Médico Nacional "20 de Noviembre" Institute for Social Security and Services for State Workers, Mexico City, Mexico.
2 Chief of Neurophysiology Department, Centro Médico Nacional "20 de Noviembre", Institute for Social Security and Services for State Workers, México City, México.
3 Department of Neurology, Centro Médico Nacional "20 de Noviembre" Institute for Social Security and Services for State Workers, Mexico City, Mexico.
4 Department of Translational Biomedicine, Research Division. Centro Médico Nacional "20 de Noviembre" Institute for Social Security and Services for State Workers, Mexico City, Mexico.
5 Department of Molecular Biology. Genomic Medicine, Research Division. Centro Médico Nacional "20 de Noviembre" Institute for Social Security and Services for State Workers, Mexico City, Mexico.
6 Neurologist, Chief of Clinical Investigation Department. Centro Médico Nacional "20 de Noviembre" Institute for Social Security and Services for State Workers, Mexico City, Mexico.

Correspondence to: Christian Gabriel Toledo-Lozano, MD., MSc.
Rosa de los Ángeles 71, Colonia Molino de Rosas,
Delegación Álvaro Obregón, Ciudad de México. C.P. 01470, Mexico.
TEL: +525519562089; E-MAIL: drchristiantoledo@gmail.com

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Abstract

INTRODUCTION: Obstructive sleep apnea syndrome (OSA) occurs in 2–4% of adults, increasing by 2.5 times the risk of sudden death. **OBJECTIVE:** Establish the concordance of the clinical diagnostic and electrical diagnosis in an adult series that underwent polysomnography. **MATERIALS AND METHODS:** Patients with sleep disorders that underwent consecutively polysomnography recording. **RESULTS:** In this study, 51 subjects from 24 to 77 years old (54.1±12.12) were included in the study; 23 males and 28 females; 78.43% were overweight or obese; 35.29% were smokers; 31.37% alcohol consumers; 47.05% hypertensive; 21% diabetics; 35.29% with airway alterations; 29.41% with depression; 13.72% dyslipidaemic and 7.84% with ischemic heart disease. Only 22 of the subjects qualified for OSA and the concordance between the clinical diagnostic and polysomnographic recording was 54% (Ko=0.60, Ke 0.50, Ka=0.20) with a 0.55 sensibility, 0.66 specificity, PPV 0.54, NPV 0.65, PLR 1.2, RVN 0.69 and PPP 0.47. The neck circumference in OSA was 40.68±5 vs. 37.7±3.5 cm. (p<0.02) and BMI was 36.48±13.16 vs 29.37±6.58 (p<0.008); male/female proportion was 1.8:1 (p<0.01), BMI was higher in OSA (p<0.002). The Epworth Sleepiness Scale did not discriminate between OSA and other sleep alteration (p<0.29). **DISCUSSION AND CONCLUSIONS:** We observed a poor agreement between clinical diagnosis and polysomnography. The Epworth Sleepiness Scale did not discern between OSA and other sleep disorders and finally there was no association with a systemic process.

ORIGINAL ARTICLE

Abbreviations:

OSA	- Obstructive sleep apnea syndrome
AASM	- Academy of Sleep Medicine
Hz	- Hertz
EOG	- Electro-oculographic derivations
AVF	- Augmented vector foot
AVR	- Augmented vector right
REM	- Rapid Eye Movement
Non REM	- Non Rapid Eye Movement

INTRODUCTION

Obstructive sleep apnea (OSA) is the most common sleep-related breathing disorder. The signs, symptoms and consequences of OSA are a direct result of the derangements that occur due to repetitive collapse of the upper airway: sleep fragmentation, hypoxemia, hypercapnia, marked swings in intrathoracic pressure, and increased sympathetic activity (The Report of an American Academy of Sleep Medicine Task Force 1999; Epstein *et al.* 2009). The prevalence in adult population has increased over the last two decades (Peppard *et al.* 2007). The most current prevalence study estimates that moderate to severe sleep-disordered breathing (apnea-hypopnea index, measured as events/hour, ≥15) is among 10% of men between 30–49-year-old; 17% among 50–70-year-old men; 3% among 30–49-year-old women; and 9% among 50–70-year-old women. OSA is characterized by recurrent, functional collapse during sleep of the velopharyngeal and/or oropharyngeal airway, causing a substantially reduction or complete cessation of the airflow despite ongoing breathing efforts. This leads to intermittent disturbances in gas exchange and sleep fragmentation (The Report of an American Academy of Sleep Medicine Task Force 1999; Ferrier *et al.* 2005). OSA is associated with excessive daytime sleepiness, inattention, and fatigue, which may impair daily function, induce or exacerbate cognitive deficits, and increase the likelihood of errors and accidents. Patients with OSA are at increased risk for a broad range of cardiovascular morbidities, including systemic hypertension (Logan *et al.* 2001); pulmonary arterial hypertension, coronary artery disease (Peker *et al.* 1999; Mooe *et al.* 2001); cardiac arrhythmias, heart failure (Javaheri 2006; Chan *et al.* 1997); and strokes (Bassetti *et al.* 1999; Good *et al.* 1996; Kaneko *et al.* 2003). Patients with untreated severe OSA have a two- to threefold increased risk of all-cause mortality compared with individuals without OSA, independent of other risk factors such as obesity and cardiovascular disease (Zhang *et al.* 2013).

The diagnosis of OSA is based upon the presence or absence of related symptoms, as well as the frequency of respiratory events during sleep as measured by polysomnography or home sleep apnea testing (HSAT), according to the guidelines from the American Academy of Sleep Medicine (AASM) (The Report of an American Academy of Sleep Medicine Task Force 1999; Epstein *et al.* 2009). Daytime sleepiness is a common feature of OSA. It is often unclear whether a patient's complaint of daytime sleepiness represents true sleepiness or fatigue, or is due to the lack of physical or mental energy. In such cases the Epworth Sleepiness Scale can be used to quantitatively document the patient's perception of sleepiness, fatigue, or both (Johns 1991). Objective diagnostic testing is necessary to diagnose OSA because the clinical features are nonspecific and the diagnostic accuracy of clinical impression alone is poor (Myers *et al.* 2013).

The purpose of this study was to determine the polysomnography (PSG) findings in adults with clinical examination-based OSA suspected diagnosis. We aimed to define the relationship between PSG-confirmed OSA and clinical examination-based OSA suspected diagnosis as well as the demographic characteristics and comorbid conditions of the patients in a Mexican adult population referred to a national referral center specialized in neurophysiology.

MATERIAL AND METHODS

A cross-sectional and analytical study was conducted from January 1st, 2011 to December 31, 2013. We included patients older than 18 years old with the clinical examination-based OSA suspected diagnosis referred to polysomnography testing. Informed consent was obtained for participation in this study. Patients with any condition that would prevented the completion of the polysomnography were excluded.

Demographic variables, anthropometry, and health history focusing on cardiovascular risk factors were evaluated. A validated Spanish language version Epworth Sleepiness Scale was performed (Sandoval-Rincon *et al.* 2013; Chica-Urzola *et al.* 2007).

Polysomnography tests were conducted in a sleep laboratory during night with minimal continuous recording of 6 hours. We tried to reproduce environmental physiological sleep conditions. We followed procedures and recommendations from the latest edition of the AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications (Berry *et al.* 2015).

We used a 40-channel equipment "Neuronic" Model E8.5. Active and reference electrode were located according to the international system 10-20: F4-M1, C4-M1 y O2-M1, F3-M2, C3-M2 y O2-M2. We set impedances below 5000 Ohms and used high and low frequency filters between 1–70 Hz and a 60 Hz notch filter. Electro-oculographic derivations (EOG) were used for eye movements monitorization; active electrodes were located one centimeter outside and above the outer edge in the left eye and one centimeter outside and below the right eye. For electromyography recording, superficial electrodes were placed on the mandibular angle and on anterior tibia muscles. Airflow signals were recorded by thermal sensor; respiratory effort

was recorded by two bands: one located above the diaphragm and the other one under the umbilicus. Oxygen saturation was measured by infrared light oximetry. We placed electrodes on AVR and AVF for electrocardiographic recording.

Polysomnography test was evaluated in conventional intervals of 30 seconds. Sleep events analysis was associated with sleep stage. All procedures and data collection were performed in compliance to latest edition of the AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications. At less two neurophysiologists with expertise in sleep medicine evaluated the polysomnography data.

RESULTS

We evaluated fifty-one patients and their PSG data. Twenty-three (45.09%) were males (54.17±12.52-year-old) and twenty-eight (54.9%) were females (54.08±12-year-old) (p=0.96). Anthropometry and comorbidities are summarized in Table 1.

From the evaluation of the patients, we observed that forty of fifty-one (78.43%) had elevated BMI. Overweight was found in twenty patients (39.21%), six (11.76%) had grade I obesity; five (9.80%) had grade II obesity and nine (17.64%) had grade III obesity (p<0.68). Eighteen (35.29%) patients had upper airway trauma history; adenoid hypertrophy was found in six (11.76%) and deviated nasal septum was detected in four patients (7.84%). One patient had acromegaly and another patient both deviated nasal septum and chronic rhinosinusitis. Adenoidal hypertrophy plus deviated nasal septum and macroglossia was found in another patient. One patient had redundant palate and chronic rhinosinusitis.

Twenty-nine (56.86%) patients had a history of chronic systemic disease: twenty-four were hypertensive (47%); fifteen (29.41%) had major depression; eleven (21.56%) had diabetes mellitus type 2; four (7.84%) had ischemic heart disease history. Polycythemia was found in two patients. One patient had chronic obstructive pulmonary disease diagnosis; five (9.8%) patients had more than one comorbility (p<0.29).

Polysomnography features are summarized in Table 2. This data showed that twenty two out of fifty-one complied OSAS diagnosis by PSG criteria (see Table 3). Since the polysomnography study is considered the gold standard for OSAS diagnosis, the sensitivity of clinical assessment was 0.55, with specificity of 0.66, positive predictive value (PPV) of 0.54, negative predictive value (NPV) of 0.65, positive likelihood ratio (PLR) of 1.2, negative likelihood ratio (NLR) 0.69 and post-test probability de 0.47 (PPP).

In PSG-confirmed OSAS group, ten patients had mild OSAS; six patients had moderate OSAS and six had severe OSA. PSG-confirmed OSAS was more frequent in males than in females (14 vs 8), with a ratio of 1.7:1 (p<0.01). Body Mass Index was significantly higher among patients with OSAS (p<0.04) as well as the neck perimeter (p<0.02); while age (p<0.37), the Epworth Sleepiness Scale (p<0.82), and upper airway trauma history (p<0.20) did not correlate with PSG-confirmed OSAS.

Using a logistic regression model, OSAS diagnosis did not correlate with current smoking (p<0.67), diabetes mellitus type 2 (p<0.69), hypertension (p<0.41) and alcohol consumption (p<0.14).

DISCUSSION

OSAS is a disorder that is characterized by obstructive apneas and hypopneas caused by repetitive collapse of the upper airway during sleep. Each event of apnea causes hypoxemia and hypercapnia and if is prolonged

Tab. 1. Characteristics of the patients studied.

Comorbidity	Male	Female	total	OSAS*	Other sleep disorders	*p*-value
Systemic diseases	12	17	29	14	16	0.50
Smokers	8	10	18	10	8	0.37
Alcohol consumers	10	6	16	10	6	0.14
Hypertensive	13	11	24	13	11	0.79
Depression	4	11	15	4	11	0.08
Diabetes Mellitus	7	4	11	8	3	0.69
Airway alterations	8	10	18	10	8	0.12
			Media			
The Epworth Sleepiness Scale (score)	10±6.67	9.48±6.1	10.9±7.1	11.35±6.65	9.36±6.69	0.29
Neck perimeter (cm.)	39±4.5	38±3.9.	31.25±4.8	40.67±5	37.7±13.16	0.02
Body Mass Index	32.6±10.6	31.25±7.76	33.7±12.51	36.48±13.16	29.37±6.58	0.04

* Obstructive sleep apnea syndrome diagnosed according to PSG criteria

Tab. 2. Polysomnography features.

	Global	OSAS*	No OSAS*	*p*-value
Total time of recording/min	491.96±45	476.18±52.63	498.1±41.5	0.26
Total sleep time/min	282.96±92.24	285.25±86.6	281.28±91.1	0.88
Sleep latency/min	27±24.8	20.17±14.4	32.73±30.19	0.05
Latency of MOR/min	62.38±86.56	52.87±71.68	70.19±97.74	0.46
Total awake time	178.84±92.56	171.01±87.56	185.28±97.6	0.56
Phase N1	57.66±40.7	60.89±44.11	55±38.2	0.61
Phase N2	134.8±65.4	133.16±68.85	136±63.55	0.87
Phase N3	35.6±39.7	37.84± 44.8	34.444±35.74	0.76
MOR		53.21±33.3	59.53±35.37	0.51
Stage N1 %	20.1±14.2	21.61 ± 14.86	19±13.81	0.52
Stage N2 %	46.5±15.7	45.75±16	47.09±15.6	0.76
Stage N3 %	13.2±15.7			
Sleep MOR %	20.12±11.4	19.23±11.06	20.85±11.8	0.6
Number obstructive apneas		41.13± 80.13	1.8±3	0.01
Number mixed apneas		10.4±18.3	0.4±1.2	0.006
Number of central apneas		13.08±20.12	1.1±2.8	0.003
Apnea index	6±12.9	12.68±17.1	0.6 ±0.8	0.0001
So_2	89.3±6.3	86.5±7.8	91.6±3.4	0.007
So_2 in sleep	76.7±13.5	71.2± 14	81.1±11.2	0.009

*Obstructive sleep apnea syndrome **REM Rapid eye movement

Tab. 3. Definitive diagnosis and PSG-confirmed OSAS.

Definitive Diagnosis	Male	Female	Total
OSAS	11	11	22
Catathrenia	3	3	6
Unspecified daytime sleepiness	6	9	15
Chronic insomnia	1	4	5
Narcolepsy	0	1	1
Restless Legs Syndrome	1	0	1
Night terrors	1	0	1
OSAS	**14**	**8**	**22**
No OSAS	**9**	**20**	**29**

it increases the intrapleural negativity as a compensatory mechanism to overcome the "obstruction". Additionally, hypercapnia stimulates the Central Nervous System (CNS) increasing systemic adrenergic activity so if these abnormalities are perpetuated they may cause or worsens hypertension and cardiac arrhythmias, which explains the increased risk of sudden death in these patients. Although there is no consensus about the risk factors and comorbidities associated to OSAS, age has demonstrated a linearly correlation because of the increase in para-pharyngeal fat, decrease in the caliber and the reduction of pharyngeal reflexes and increased in the airway resistance associated to aging. In this investigation, we did not found association of OSAS to age maybe because only 3 patients, over 90 years old, qualified to OSAS diagnosis.

Marin *et al.* 1997 reported that OSAS is more frequently in male vs females 2.2% vs. 0.8%. In a Latin-American study, were Mexico City was included (Torre-Bouscoulet *et al.* 2008*),* found that the male/female relation was 4.4% vs 2.4% respectively; if the comparison was made in the community vs a sleeping clinic the ratio was 10:1 to 4:2 (Gharibeh *et al.* 2010). As expected, we found OSAS was more frequent in males (14 vs 8), in a ratio of 1.7:1 $p<0.01$ but this proportion was lower to other publications, maybe because the population studied were beneficiaries of a government organization, ISSSTE, which provides medical services to bureaucrats, a population with higher degree of education than the general population. In this series, 92.8% of women possess at least technical level, and is possible that a better level of schooling encourages them to seek proper medical support. On the other hand, maybe the reason that OSAS is more prevalent in males is that they have an upper airway with a greater length and more accumulation of para-pharyngeal fat is possible and are decisive factors for suffering more OSAS (Edwards *et al.* 2011; Patil *et al.* 2007); however, some experts disagree arguing women often have subtle clinical forms and the diagnosis is delayed or was not considered where

nonspecific symptoms as daytime sleepiness is underestimated especially if the snoring is not loud, so that Verdaquer *et al.* 2008 proposed guidelines for diagnosis in women.

Overweight and obesity increase the probability of OSAS and it is estimated that 40% of obese patients present OSAS and 70% of patients with OSAS are obese (Labarca *et al.* 2014); overweight and obesity *per se* increases the possibility of OSAS but the rapid weight changes have the greatest impact; Peppard *et al. (*2000) found that a 10% increased of weight, predicted a 0.32 probability of OSAS (IC 95%, 0.20–0.45) and six times more (IC 95%, 2, 2–17, 0) that will be moderate to severe. A meta-analysis study, stablish (Greenburg *et al.* 2009) that bariatric surgery did not improve the average rate of apnea/hypopnea in moderate to severe OSAS, so it should not be expect a cure with surgical weight loss. To this respect, it is worth considering that patients undergoing bariatric surgery are morbidly obese where in addition to obesity there are other mechanisms involved in the genesis of OSAS, however, weight loss remains an indication in OSAS, and in this series we found a significantly higher BMI among patients with OSAS ($p<0.002$) and also had significantly greater neck perimeters ($p<0.02$), this is in agreement according to the reported literature (Bedialauneta *et al.* 2007).

Unexpectedly, anatomic airway abnormalities were not associated with OSAS ($p<0.20$), and is possible that OSAS are not only an anatomical abnormality but also a functional abnormality which are not usually noted in the medical history. Craniofacial processes cause catatrenia with or without apnea, a symptom referred by only six patients, perhaps because the relationship between man and woman was lower and in women this phenomenon is less outstanding.

In this study, alcohol consumption was not associated with OSAS. A deleterious effect on sleep is attributed to alcohol because it interrupts latencies, diminishes total sleeping time, increases the appearance of slow wave sleep and suppresses REM sleep (Brower 2001) it also decreases the activity of the genioglossus, were it is decreased in response to hypoxia/hypercapnia and increased the resistance of the upper area via. In this study, neither alcohol consumption is associated with OSAS (Peppard *et al.* 2007).

Gupta *et al. 2015* reported a higher prevalence of OSAS in patients with depression and post-traumatic stress syndrome and in this series depression tended to be associated with no significance to OSAS ($p<0.08$).

The proinflammatory state resulted of hypoxia/hypercapnia associated to OSAS promotes the systemic processes such as DM, hypertension, cardiac arrhythmias, smoking and dyslipidemia. There are more prevalent in this population, more difficult to control and have early complications (Ayas *et al.* 2014); surprisingly in this series there was no such association. Until now we do not have a satisfactory explanation to this finding, but it is likely due in the failing to carry out timely screening tests, so our results may be deficient, in contrast to other factors such as gender, overweight/obesity and substances consumption that were consistent with other studies, also we must consider that a relatively small group was studied.

The lack of agreement between the clinical diagnosis and polysomnography recording was the most significant and relevant finding of our study. Although there is no gold standard for diagnosis of OSAS, polysomnography (80% sensibility, 97% specificity) is the reference. In this series the concordance was less than 50%, which highlights the necessity to improve the clinical evaluation, make it systematic and include the use of validated instruments for example Berlin or Wisconsin surveys (Abrishami *et al.* 2010), that can enable a better assessment even to doctors unfamiliar to the subject without neglecting the need for better communication between those who require this diagnostic and those who perform it. This observation probably reflex the inexperience in sleep disorders among the health staff that referred these patients or the little care to make the requisitions of the study. Any of these reasons affect the patient, so it is an area that can improve with training programs that can make more timely diagnosis that would reduce job losses in economically productive persons and in health cost.

Another striking finding was on the Epworth Sleepiness Scale, a widely validated instrument used to detect pathological daytime sleepiness and therefore OSA (Johns 1991), did not discriminate between the different causes that originate the illness (Dauvilliers 2006; Carter *et al.* 2014), although this tool is very sensitive in detecting pathological sleepiness. This explains why the overall scores were above the cutoff points for daytime sleepiness but will not differentiate between OSA vs other sleep disorders. This tool is useful when compared with people without sleep problems vs OSA, but when patients are included with other sleep problems the discriminative capacity is limited so it is advisable to use other evaluation tools.

In this series, we look at most of the comorbidities associated with OSAS in a circumscribed population which strengthens our study. Our results invite us to have closer relationships with those requesting the study and have the necessary information that will lead to a better diagnosis treatment options and quality of life for patients.

CONCLUSIONS

A liner relation between BMI, neck perimeter and OSAS was found.

OSAS ration between male/female was lower than other series, and it is notable that no associations with systemic problems are found.

No concordance was found with the clinical diagnosis and polysomnography, which requests an inspection

in the clinical guidelines establish them as complementary tools, not equivalent.

The Epworth Sleepiness Scale so widely used in OSA, did not discriminate between OSA and other sleep deserters so more powerful tools are required if it's in the interest to delve into the study of certain sleep disorders

Conflict of interest

The authors declare that they have no conflict of interest.

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