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Role of overnight pulse oximetry in diagnosis of obstructive sleep apnea syndrome

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ABSTRACT

Background: Obstructive sleep apnea hypopnea syndrome (OSAHS) is a serious public health concern in terms of incidence. Despite being the golden measure for determining the quality of sleep and detecting sleep disrupted breathing, polysomnography (PSG) is costly, consuming time, labor-intensive, less widely accessible, needs continuous observation and skill for the interpretation.

Aim of The Work: To evaluate the sensitivity and specificity of overnight pulse oximetry (OPO) as a technique for detecting OSAHS, .

Patients and Methods: This cross-sectional research was done at Bab El-Shaaria University Hospitals in Cairo. In total, fifty persons were included in this research: forty patients were suffering from the manifestations of OSAHS who diagnosed by PSG and have apnea hypopnea index more than or equal to five (≥ 5) and ten apparently healthy persons were incorporated as a control group who have not OSAHS by PSG and well matched to the patients for age, sex and BMI (body mass index).

Results: With 85% sensitivity and 60% specificity, the estimated cutoff value of OPO utilizing oxygen desaturation index (ODI) for OSAHS patient diagnosis was 17.77. The projected OPO cutoff value for severe OSAHS patient diagnosis employing the ODI was 51.115, with 80% sensitivity and 90% specificity.

Conclusion: A low-cost screening approach for OSAHS patients that has good sensitivity, specificity and accuracy that becomes better with severity is overnight pulse oximetry.

Keywords: *: OSAHS; polysomnography; nighttime pulse oximetry; apnea hypopnea index.*

INTRODUCTION

Obstructive sleep apnea hypopnea syndrome (OSAHS) is a serious public health concern in terms of incidence. Despite being the golden measure for determining the quality of sleep and detecting sleep disrupted breathing, polysomnography (PSG) is costly, consuming time, labor-intensive, less widely accessible, needs continuous observation and skill for the interpretation[1].

Because of its elevated incidence rates, elevated morbidity and death that impacts both children and adults, obstructive sleep apnea hypopnea syndrome (OSAHS) is a serious public health issue[2].

OSAHS is marked by repeated bouts of upper airway obstruction in sleep that commonly lead to a decrease in blood oxygen saturation with short awakenings and the afflicted individuals experience fragmented sleep and excessive daytime drowsiness [3].

Full-night monitored polysomnography (PSG), which offers precise information on phase of sleep, air flow and oxygen levels, pulse rate and rhythm, body posture, muscle mass and contractions is the ideal benchmark for the diagnosing OSAHS. However, this treatment is restricted by the requirement for specialized facilities, skilled personnel and admittance into a sleep laboratory, high costs and lengthy waiting lists. Patients in a sleep laboratory often consume higher time sleeping supine because the equipment is more extensive and may induce alterations in sleep and as a result patients do not sleep well in a sleep laboratory and can degrade actual sleep quality [4].

Due to its low cost, ability to satisfy the high demand for diagnostic testing in the community and ease of use, OPO was chosen as a simpler substitute to PSG in the screening and detection of OSAHS[5].

The AHI, which counts all apneas and hypopneas throughout a sleep cycle, is the accepted method for determining the severity of OSAHS. Patients are classified into three categories based on their AHI results: mild OSAHS, defined as having an AHI of 5 to 14; intermediate OSA, defined as having an AHI of 15 to 29; and severe OSAHS, defined as having AHI more than or equal to thirty (≥30/hr.). [6]

In line with the guidance of the American Academy of Sleep Medicine, The Oxygen Desaturation Index (ODI) is the frequency with which the blood oxygen saturation level decreases from baseline throughout each sleep cycle. Any respiratory event that generates a 3 degree or greater decline in blood oxygen saturation levels results in a rise in the ODI.[7]

This study's objectives were to examine the sensitivity and specificity of overnight oximetry as a diagnosing tool in patients who were thought to have OSAHS and to minimize the number of PSG procedures that could have been avoided if the assessment of OSAHS had been made utilizing this technique.

PATIENTS AND METHODS

This cross-sectional research was carried out at the Sleep Disorders Breathing Unit in Bab El-Shaaria University Hospitals in Cairo; Egypt from July 2021 to April 2022. In total, fifty persons were included in this research: forty patients were suffering from the manifestations of OSAHS who diagnosed by PSG and have AHI $\geq$ 5 and ten apparently healthy persons were incorporated as a control group who have not OSAHS by PSG and well matched to the patients for age, gender and body mass index. Patient's group subdivision was according to AHI into mild to intermediate OSAHS have AHI 5-29/ hr. and severe OSAHS have AHI $\geq$30/hr.

Inclusion criteria: Patients with symptoms suggestive of OSAHS and positive OSAHS by PSG (40 patients) were included in this study, without clinical or laboratory evidence of chronic lung disease with daytime hypoxemia and daytime normoxemia and normocapnia based on arterial blood gases (ABGs).

Exclusion criteria: Patients having a history of stroke, pulmonary or cardiac conditions linked to ventilatory or diffusion defects during the day, hypoxemia, hypercapnia, or central sleep apnea, as well as those with generalized muscle or neurological abnormalities were not included in the study.

Methods: The research got approval by the Al-Azhar University's Faculty of Medicine's ethics committee. Every person signed a written or verbal agreement for participation in this research after being informed about the procedure. All persons underwent the following: Complete medical history taking with special emphasis on age, gender, occupation and clinical signs of OSAHS (Observed apnea, nocturnal choking, snoring and increased daytime drowsiness); OSAHS screening questionnaires like the Stopbang (SQ), Berlin (BQ) questionnaire and the Epworth Sleepiness Scale (ESS); laboratory tests with emphasis on complete blood count (CBC) and arterial blood gases (ABGs); general exam with emphasis on BMI in kg/m2 , neck circumference (NC) in cm and cardiac, chest, ears, nose and throat examinations, chest x-ray (postero-anterior view) to detect any associated condition, Overnight pulse oximetry(OPO) and full-night PSG. To evaluate brain activity, muscle tone, eye movements, ECG, oxygen saturation, chest and abdominal wall movements, airflow and snoring, PSG data were collected utilizing a PSG computer system (PSG Model: Neuron- Spectrum- AM). The diagnostic precision of the OPO (Model YH-600B Pro) was compared to that of full-night PSG. A flexible probe was used to connect wrist oximetry to the participant's finger. Twenty data points per minute are detected by the device, each of which corresponds to the lowest saturation throughout a 3-s period. During sleep, wrist oximetry monitors the continuous monitoring of oxygen saturation and heart rate. The computer is then uploaded with this data, where specialized software is used to analyze them. It is possible to see the relationship between pulse rate and pulse oximeter oxygen saturation (SpO2) over time using a graph. When the hemoglobin saturation level decreased by less than 3% from the baseline saturation, it was deemed a desaturation event. The mean saturation from the preceding minute was used as the baseline saturation. Statistical analysis: The statistical program for social science (SPSS) version 24 was utilized to examine the data. To represent quantitative data, the mean and standard deviation were utilized. To express qualitative data, frequency and proportion were utilized. The center value of a discrete collection of numbers, namely the sum of values divided by the number of values, is called the mean (average). The standard deviation (SD) is a measure of a collection of values' dispersions. A low SD implies that the values are spread out across a larger range, while a higher SD reveals that the values are near to the set's mean. When comparing non-parametric data, the Chi-square test was utilized. For data correlation, the Pearson correlation coefficient was applied. P-values < 0.05 were deemed substantial, P-values < 0.001 were considered very substantial, whereas P-values > 0.05 were considered insignificant. The receiver operating characteristic curve analysis was also able to differentiate between diseased patients and normal ones.

RESULTS

Patient characteristics	Non OSAHS (N=10)	OSAHS (N=40)	Statistical test	P value
Sex [N (%)]				
Male	6 (60%)	22 (55%)	χ^2= 0.005	0.94
Female	4 (40%)	18 (45%)		
Mean ± SD				
Age (years)	45.8 ± 9.24	46.35 ± 9.73	t= 0.15	0.87
BMI (kg/m^2)	37.69 ± 2.46	38.07 ± 3.91	t= 0.29	0.77
NC (cm)	38.4 ± 2.06	41.52 ± 3.4	t= 2.72	0.009*
ESS	5.3 ± 3.03	15.67 ± 3.25	t= 8.95	< 0.001**
SBQ	1.2 ± 0.74	4.47 ± 1.59	t= 6.18	< 0.001**
BQ	0.6 ± 0.48	1.87 ± 0.87	t= 4.36	< 0.001**

Student t- test (t); Chi-Square test (χ2); * Significant P < 0.05

SD: standard deviation; BMI: Body mass index; NC: Neck circumference; ESS: Epworth Sleepiness Scale; SBQ: Stopbang questionnaire; BQ: Berlin questionnaire; N: number(s).

Table 1: Demographic data, anthropometric measures and obstructive sleep apnea screening questionnaires in OSAHS patients versus non OSAHS group.

There were significantly higher NC, SBQ, ESS and BQ among OSAHS patients than non OSAHS group. On the other hand, there were no significant difference as regard sex distribution, BMI and age.

	Non OSAHS (N=10)	OSAHS (N=40)	T	P value
AHI(event/hour)	2.1 ± 1.13	30.25 ± 16.1	5.41	<0.001*
Minimal SpO2	88.0 ± 2.75	80.15 ± 3.84	5.95	<0.001*
Baseline O_2sat	94.00 ± 1.33	93.48 ± 2.48	0.643	0.523
ODI(event/hour)	2.53 ± 1.07	41.89 ± 30.87	8.045	<0.001*
Total arousal	14.6 ± 3.0	32.77 ± 6.68	8.21	<0.001*
SpO2 time <90% (minute)	0.77 ± 1.01	26.75 ± 8.07	9.94	<0.001*

Student t-test (t); * Significant P < 0.05 AHI: Apnea hypopnea index; ODI: Oxygen desaturation index; OSAHS: obstructive sleep apnea hypopnea syndrome; SpO2: pulse oximeter oxygen saturation; N: number(s).

Table 2: Polysomnographic parameters of OSAHS patients versus non OSAHS groups.

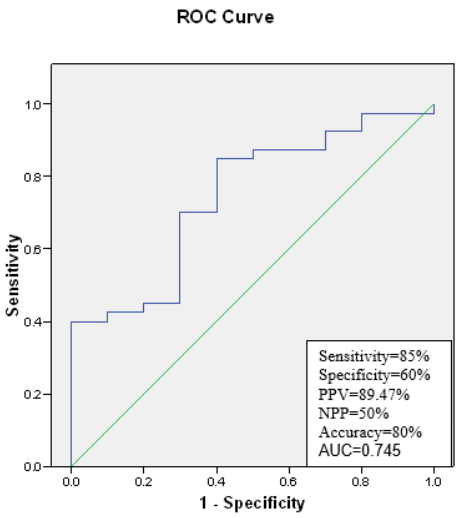
About polysomnographic parameters there were significantly higher AHI, ODI, total arousal and Spo2 time < 90% among OSAHS patients than non OSAHS group .On the other hand ; minimal Spo2 was substantially lower among OSAHS patients than non OSAHS group , while there was no significant difference as regard baseline O2 saturation.

Items	ODI for diagnosis of OSAHS
Cut off point	17.77
Area under the curve	0.745
Sensitivity	85%
Specificity	60%
PPV	89.47%
NPV	50%
Accuracy	80%
P value	0.017*

* Significant P < 0.05 PPV: positive predictive value; NPV: negative predictive value; ODI: Oxygen desaturation index.

Table (3): Validity of OPO in detection of OSAHS patients depending on ODI.

The cutoff point of 17.77 for OSAHS patients can be used as a predictor for diagnosis of OSAHS with 85% sensitivity, 60% specificity , 89.47% PPV, 50% NPV and significant p value 0.017*



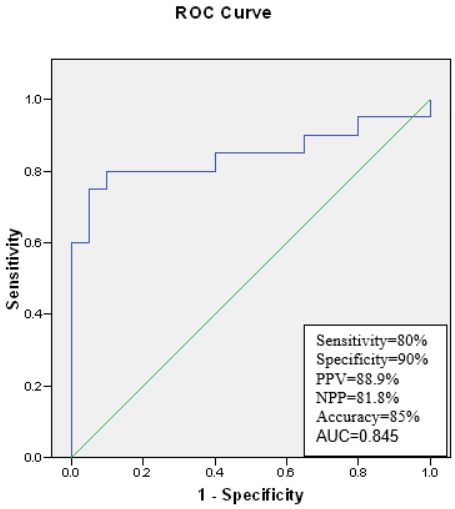
PPV: positive predictive value; NPV: negative predictive value;
AUC: Area under the curve

Fig. 1: Receiver operating characteristic (ROC) curve analysis of oxygen desaturation index (ODI) diagnostic features of OSAHS patients.

Items	ODI for severe OSAHS
Cut off point	51.115
Area under the curve	0.845
Sensitivity	80%
Specificity	90%
PPV	88.9%
NPV	81.8%
Accuracy	85%
P value	< 0.001*

* Significant P < 0.05 PPV: positive predictive value; NPV: negative predictive value; ODI: Oxygen desaturation index.

Table 4: Validity of OPO for prediction of severe OSAHS patients depending on ODI. The cutoff point of 51.115 for severe OSAHS patients can be used as a predictor for severe OSAHS with 80% sensitivity, 90% specificity, 88.9% PPV, 81.8% NPV and highly significant p value < 0.001*.



PPV: positive predictive value; NPV: negative predictive value;
AUC: Area under the curve

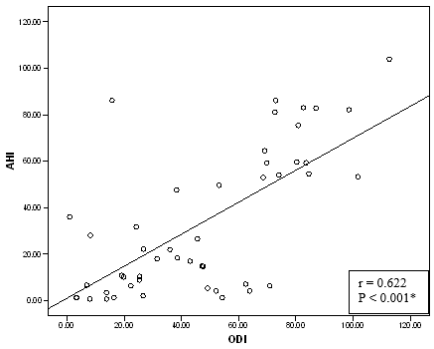
Fig. 2: Receiver operating characteristic (ROC) curve analysis of oxygen desaturation index (ODI) parameters for severe OSAHS patients.

	ODI of overnight pulse oximetry	
	r	P value
AHI of full night PSG	0.622	< 0.001*

Spearman correlation coefficient (r); * substantial P < 0.05
AHI: Apnea hypopnea index; PSG: Polysomnography; ODI: Oxygen desaturation index

Table 5: Correlation between AHI of full night PSG and ODI of overnight pulse oximetry.

There was positive correlation between AHI of full night PSG and ODI of overnight pulse oximetry (r =0.622) with highly Significant p value <0.001*.



Spearman correlation coefficient (r);* Significant P < 0.05
AHI: Apnea hypopnea index; ODI: Oxygen desaturation index

Figure 3: Correlation between AHI of full night PSG and ODI of overnight pulse oximetry

DISCUSSION

Due to the high incidence, which can reach up to 25% in middle-aged adults, obstructive sleep apnea hypopnea syndrome (OSAHS) is a significant public health concern. It is marked by repeated upper airway collapse throughout sleep, which are connected to recurrent oxygen desaturations and awakenings from sleep[8]. The gold standard test for identifying sleep-related respiratory problems like obstructive sleep apnea, central sleep apnea and sleep-related hypoventilation/hypoxia is a polysomnography, but admittance to a sleep lab is necessary, time-consuming, high coast and difficult to perform due to a lack of equipment, expertise and a lengthy waiting list. As a result, many OSAHS go undetected and unmanaged [9]. Overnight pulse oximetry (OPO), which is performed during the night and better illustrates the patient's respiratory and oxygenation condition, has become possible in recent years due to technological advancement. During a routine OPO, it is possible to determine the median overnight pulse oximeter oxygen saturation (median SpO2) and lowest SpO2 throughout the entire night recording.[10] OPO is an appealing substitute for polysomnographic studies for the OSAHS screening in individuals with a high pre-test suspicion since it is affordable, accessible and may be done outside of a hospital setting .[11] This research sought to assess the validity of OPO in diagnosis of OSAHS and decreased number of saved patients for polysomnography. This research revealed that NC was significantly higher among OSAHS (41.52 ± 3.40) than non OSAHS (38.4 ± 2.06) with significant p value = 0.009* table (1). NC is a major risk factor for OSAHS as documented by Pattanshetty and Chopde.[12] This study showed that screening questionnaires such as Epworth sleepiness scale (ESS), Stop-bang (SQ) and Berlin questionnaire (BQ) were significantly higher among OSAHS patients than non OSAHS group as shown in table (1). This is supported by Trimer et al. [13] who found in their study that the ESS was higher in OSAHS group in comparison to control group. Chung et al. [14] noted that with increasing the score of SQ to 7 or 8, the probability of severe OSAHS increases. Lü et al. [15] in their study showed that there was significantly higher BQ questionnaire among OSAHS patients than non OASHS group. This research found that; as regarding polysomnographic parameters there were significantly higher AHI, ODI, total arousal and Spo_2 Time <90% among OSAHS patients than non OSAHS group but minimal Spo_2 was significantly lower among OSAHS patients than non OSAHS group , while there was non-significant difference as regard baseline O_2 saturation with p value for AHI, ODI, total arousal , Spo_2 Time <90% , minimal Spo_2 and baseline O_2 saturation (< 0.001 , < 0.001 , < 0.001,< 0.001, < 0.001 and 0.523 respectively) table(2). This is supported by research done by Trimer et al. [13] who showed that AHI, arousal index, apnea/hours of sleep, hypopnea/hours of sleep and ODI were all substantially greater in OSAHS patients than in the control group. Other study done by Kuźmińska et al.[16] found that there were lower values of minimum saturation in OSAHS patients in comparing to non OSAHS group. This research evaluated the role of OPO by detecting cutoff values of ODI for detecting OSAHS patients using ROC curve. The efficient cutoff values of ODI of OPO in diagnosis OSAHS patients was 17.77 which is the golden standards to evaluate whether the OSAHS or not with 85% sensitivity, 60% specificity, 80% accuracy and significant p value 0.017 table (3) while the efficient cutoff values of ODI of OPO in severe OSAHS patients was 51.115 with 80% sensitivity, 90 % specificity, 85% accuracy and greatly substantial p value < 0.001 table (4). This is agreed with the research of Hang et al.[17] who concluded that the OPO threshold value for OSAHS identification was 21.2 with an accuracy of 87.77%, sensitivity of 88.53% and specificity of 85.34%. While the OPO sensitivity, specificity and accuracy for severe OSAHS were 52.5500, 86.67%, 96.8% and 92.5%, respectively, with improved sensitivity, specificity and accuracy with severity. Therefore, this research came to the conclusion that OPO is a useful diagnostic for identifying individuals with mild to moderate sleep apnea. This research found an AHI of full-night PSG and an ODI of overnight pulse oximetry to be positively correlated (r =0.622, extremely substantial p value< 0.001) table (5). This is supported by a study done by Sharma et al.[18]who found that there was a high connection between ODI from OPO in the hospital and AHI from post discharge in-laboratory PSG. This also agreed with Dumitrache- Rujinski et al.[19] who noted that a substantial positive connection was found between the desaturation index from pulse oximetry and AHI of full night PSG with highly substantial p value (p <0.001). In a previous study done by Chung et al.[20] and Shi et al.[21] showed similar findings regarding connection between ODI of OPO and AHI of full night PSG.

LIMITATIONS

It was done at a single center. However, multi centers studies are more valuable and trustable. The number of cases enrolled in the study was small; it would have been interesting to compare the cases with OSAHS and without OSAHS and compare cases of severe OSAHS with non-severe OSAHS, so large number of cases is required. Failure of oximetry measurements to discern between desaturations brought on by obstructive apneas, central apneas and primary pulmonary illness, as well as between sleep phases and quality of sleep.

CONCLUSION

A low-cost screening approach for OSAHS patients that has good sensitivity, specificity and accuracy that becomes better with severity is overnight pulse oximetry.

Conflict of interest : none

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