Original Article

THE EFFECT OF ADDING BODY MASS INDEX (BMI) AND NECK CIRCUMFERENCE TO EPWORTH SLEEPINESS SCALE (ESS) FOR DIAGNOSING OBSTRUCTIVE SLEEP APNEA HYPOPNEA SYNDROME IN SLEEP CLINICS

Muhammad Usman Ullah, Jawad Khaliq Ansari*, Sajid Mustafavi, Raheel Iftikhar***, Waseem Raja, Wasib Husssain Shah, Sohail Khan Raja**

Military Hospital Rawalpindi Pakistan, *Army Medical College Rawalpindi, National University of Medical Sciences Rawalpindi Pakistan, **Rawal Institute of Medical Sciences, ***141 Medical battalion,

ABSTRACT

Objective: To study the effect of adding body mass index and neck circumference to Epworth Sleepiness Scale (ESS) for diagnosing obstructive sleep apnea hypopnea syndrome in sleep clinics.

Study Design: Cross sectional validation study.

Place and Duration of Study: Department of Pulmonology, Military Hospital Rawalpindi from 1st July 2013 to 01 September 2014.

Material and Methods: The ESS and ESS plus body mass index (BMI) and neck circumference (NC) data was evaluated for 150 patients hospitalized in our hospital for polysomnographic evaluation of obstructive sleep apnea. Overnight polysomnography (PSG) was done for all patients and was considered the gold standard for diagnosis of OSA. ESS Scoring, BMI and NC data was done using pre-designated questionnaire. All the data was analyzed using SPSS version 19.

Results: Age ranged from 18-74 years with mean age of the study group 53 (±12.1 SD) years. Out of study population 87 (58%) were males and 63 (42%) females. In study population 80 (55.3%) patients had ESS >10. while 102 patients had ESS>10 with BMI > 35 kg/m2 and NC>40 cm. Using an AHI ≥ 5 for OSA, 136 patients (90.6%) had OSA. Sensitivity of ESS > 10 for OSA was 55.15 % but increased to 72.79% when BMI > 35 kg/m2 and NC > 40 cm was added to patients with ESS > 10. Similarly specificity and predictive values of study population for diagnosing OSA also increased after adding BMI and NC to ESS.

Conclusions: In this study adding body mass index (BMI) and NC to ESS score significantly increased the sensitivity and specificity and positive predictive value for diagnosis of OSA.

Keywords: Obstructive sleep apnea, Polysomnography, Questionnaires, Sensitivity.

INTRODUCTION

Obstructive sleep apnea (OSA) is a disorder of sleep involving cessation or significant reduction in airflow in presence of breathing effort. It is characterized by recurrent episodes of upper airway collapse during sleep resulting in repeated oxyhemoglobin desaturations and sleep arousals[1]. When combined with excessive daytime somnolence, term obstructive sleep apnea hypopnea syndrome (OSAHS) is used. Despite being a relatively common disease, it is frequently overlooked and under diagnosed by physicians. It is, however, essential to diagnose OSA early because of its strong association and potential to cause debilitating medical conditions[2]. While Polysomnography is gold standard for diagnosing OSA, different scoring systems and questionnaires have been developed overtime predicting presence of OSA with varying sensitivity and specificity. Epworth sleepiness scale (ESS), Berlin Questionnaire (BQ) , STOP-BANG Questionnaire are some of frequently used scoring systems[3]. Body mass index (BMI) and neck circumference (NC) are well established indicators of obesity but they are infrequently studied as part of scoring system for OSA. This study is done to study the effect of adding BMI and NC to routinely used ESS for diagnosing OSA in sleep clinics.

Correspondence: Dr Muhammad Usman Ullah, Military Hospital Rawalpindi, Pakistan
Email: muhammadusmanullah2010@gmail.com
Received: 06 Apr 2015; revised received: 09 Apr 2015; accepted: 10 Apr 2015

MATERIAL AND METHODS

This prospective study was carried out in department of pulmonology, Military Hospital Rawalpindi, from July 2013 to September 2014. We included 150 patients referred to pulmonology department for evaluation of obstructive sleep apnea by non probability consecutive sampling. Informed written consent was taken from all patients and permission from hospital ethical committee was also sought. Sample size was calculated using WHO sample size calculator with 95% CI. Inclusion criteria included patients more than 18 years, referred for diagnostic/baseline polysomnography for OSA. Patients were excluded if they had cognitive impairment, not willing to participate in study, had known previous arrhythmias or previously being diagnosed and treated for OSA. Subjects with any thyroid disorder or Cushing's disease, and pregnant and lactating women were also excluded from the study. Demographic data, habits and associated co-morbidities of patients were recorded. BMI > 35 kg/m2 and NC > 40 cm is strongly correlated with various co morbidities and for purpose of study was added to ESS. Height and weight of patients were recorded and BMI calculated accordingly. Weight was measured with light clothing and without shoes. Height was measured without shoes. BMI was calculated by dividing weight (kg) with the square of height (m). NC was measured in the midway of the neck, between mid-cervical spine and mid anterior neck, to within 1 mm, using non-stretchable plastic tape with the subjects standing upright. In men with a laryngeal prominence (Adam's apple), it was measured just below the prominence. While taking this reading, the subject was asked to look straight ahead, with shoulders down, but not hunched. Care was taken not to involve the shoulder/neck muscles (trapezius) in the measurement. All the patients were interviewed by pulmonologist for ESS.

ESS is commonly used scale with eight questions, each carrying equal score. It is a self-administered questionnaire that asks subjects to rate how likely they would have dozed /asleep in 8 specific situations[4]. Total score greater than 10 indicates excessive daytime sleepiness. Study participants were then subjected to night PSG by Digital PSG system. Nasal pressure sensors, Oronasal breathing thermistor, thoracoabdominal movement sensors and pulse oximeter. The PSG recording was scored manually by pulmonologist who was blinded to the results of the questionnaires. Analysis of sleep records was done according to American Academy of sleep Medicine[5] Apnea was defines as more than 90% fall in peak signal excursion from pre event baseline for at least 10 seconds. Hypopnea were defined as more than 30% fall in signal excursion with associated more than 4% desaturation from pre-event baseline for 10 seconds or more. The apnea-hypopnea index (AHI) was the number of episodes of apneas or hypopneas per hour of sleep during study. OSA was defined by presence of AHI ≥5 and severity of OSA was defined as AHI ≥5-15 (mild), AHI ≥15- ≤30 (moderate), AHI ≥ 30 severe OSA. Statistical analysis was done using SPSS version 19 (IBM SPSS for windows, version 19.0, USA). Descriptive statistics were applied to summarize the data. Sensitivity, specificity, positive predictive value and negative predicitive values were calculated for ESS and ESS plus BMI and NC against polysomnography using cross tables. Chi square test was applied to compare significance between two groups, *p* value of less than 0.05 was considered significant statistically.

RESULTS

Age ranged from 18-74 years with mean age of the study group 53 (±12.1 SD) years. Out of study population 87 (58%) were males and 63 (42%) females. Mean BMI was 35.2 kg/m2 (2.1 SD) and mean NC was 43.2 cm (4.14 SD). Using PSG as gold standard with AHI ≥ 5 for OSA, 136 patients (90.6%) had OSA. In study population 80 (55.3%) patients had ESS >10 (table-1). while 102 patients had ESS>10 with BMI > 35 kg/m2 and NC>40 cm (table-2). Sensitivity of ESS > 10 for OSA was 55.15 % but increased to 72.79% when BMI > 35 kg/m2 and NC > 40 cm was added to patients with ESS > 10. Similarly specificity and predictive values of study population for diagnosing OSA also increased after adding BMI and NC to ESS (table-3). Diagnostic accuracy improved from .56 to .73 when BMI and NC were added to ESS score. When chi square test was applied to compare the two groups ,difference was significant statistically with *p*-value < 0.001. \

DISCUSSION

OSA is a chronic disorder characterized by recurrent episodes of upper airway obstruction during sleep. This results in acute derangements in gas exchange resulting in recurrent sleep arousals. Its deleterious effects on nocturnal sleep quality, causing daytime fatigue and sleepiness are widely accepted[6]. OSA has a prevalence in the range of 3% to 7%, although certain groups are at higher risk. Factors that add to vulnerability for the disorder consist of age, obesity, male sex, menopause, craniofacial abnormalities, family history, cigarette smoking and alcohol use[7]. Prevalence of OSA is estimated to be variable from 25% to 45% in obese subjects. It is a relatively common sleep disorder, yet frequently overlooked and under diagnosed with serious health implications. Various studies have shown that higher BMI and neck circumference are positively correlated with higher AHI score[8,9].

Early recognition and appropriate therapy can ameliorate the neurobehavioral consequences and may also have favorable effects on cardiovascular health. Guidelines developed in 2014 by the American College of Physicians include a recommendation that patients with daytime sleepiness should undergo a sleep study, preferably polysomnography[10]. Gold standard test for diagnosing OSA is polysomnography (PSG)[11].

Table-1: Contingency table of PSG and ESS.

	Polysomnography as gold standard		
	OSA	No OSA	Total
ESS > 10	75	5	80
ESS ≤10	61	9	70
Total	136	14	150

Table-2: Contingency table of Study population with PSG and ESS plus BMI and NC.

	Polysomnography as gold standard		
	OSA	No OSA	Total
ESS > 10 plus BMI> 35 kg/m2 and NC>40cm	99	3	102
ESS ≤10 plus BMI≤ 35 kg/m2 and NC≤ 40cm	37	11	48
Total	136	14	150

Table-3: Performance of ESS and ESS plus BMI and neck circumference for predicting OSA.

Parameter	**ESS**	**ESS plus neck circumference and BMI**
Sensitivity% (95% CI)	55.15 (46.39 -63.68)	72.79 (64.50-80.06)
Specificity% (95% CI)	64.29 (35.18-87.11)	78.57 (49.21-95.09)
Positive predictive value % (95% CI)	93.75 (86 -97.92)	97.06 (91.63- 99.36)
Negative predictive value % (95% CI)	12.86 (6.06-23.01)	22.92 (12.05-37.32)
Positive likelihood ratio (95% CI)	1.54 (0.75-3.17)	3.40 (1.24-9.31)
Negative likelihood ratio (95% CI)	0.70 (0.45-1.08)	0.35 (0.23-0.51)
Accuracy	0.56	0.73

The recordings obtained allow recognition of sleep-related apneas and hypopneas. An apnea is defined as the complete or near complete (i.e. 90%) cessation of airflow for at least 10 seconds with preserved breathing effort. Apneas may be further divided as obstructive, central, or mixed based on whether effort to breathe is present during the event. A hypopnea is defined as a reduction in airflow that is followed by an arousal from sleep or a decrease in oxyhemoglobin saturation[12]. Commonly used definitions of hypopnea require a 30% reduction in airflow associated either with a reduction in oxyhemoglobin saturation or an arousal from sleep.

Self-report questionnaires are routinely used to assess sleep quality and daytime sleepiness[13]. Over last decade , different scoring systems and questionnaires are developed. ESS, BQ, STOP-BANG scoring systems are frequently used scoring systems. .

The ESS was developed by Johns as a simple, self-administered questionnaire to assess sleep adequacy and day time sleepiness. The ESS is widely used in clinical practice and research protocols as a simple rapid assessment of subjective sleepiness[14]. Sleep disorders clinics may prioritize patients for polysomnography based on the ESS results. ESS is widely used for predicting OSA because of its convenience and simplicity. Most of the authors have found positive correlation between increasing ESS score and AHI index but there are a few contradictory studies as well. A study carried out by Hesselbacher et al showed that sensitivity of ESS for diagnosing OSA was 54% and specifityy was 57% by using a cutoff of ESS> 10[15]. In our study group the sensitivity was 65 and 68% respectively. Another study done by Rosenthal et al showed the sensitivity to be 68% and it rose to 76% if a cut off of ESS>8 was used. Different studies have correlated relation of NC with OSA. A study by Ghuman, demonstrated incremental increase in neck circumference or percentage of predicted neck circumference (based on height) was found to be significantly associated with OSA (OR = 1.23 to 5.0)[16]. However, two studies found no statistically significant association between OSA and a predetermined neck circumference greater than 43 cm for men and greater than 47 cm for women[17].

In our study when we added BMI and NC to the ESS scoring, the sensitivity of predicting OSA increased markedly. This simple clinic tool can help clinician and especially respiratory physician risk stratify group of patients whom they can send for simple overnight oximtery studies rather than PSG study. It will not only save costs but in the longer run help in diagnosing lot more undiagnosed OSA patients whose quality of life can be improved dramatically.

CONCLUSION

PSG is a labour intensive and expensive test which is currently the gold standard for the diagnosis of OSA. It is not available in all the pulmonology clinics in Pakistan. In a resourse limited settings like ours,we can use ESS score alongwith BMI and NC for predicting patients who have very high probability of having OSA and these patients should undergo simple overnight oximetry study to diagnose OSA. So far in sleep clinics this very group comprises the main OSA population cohort. Only those patients should undergo further investigation like PSG who have low ESS but still highly suspected of having OSA, patients with underlying COPD with low baseline saturations who will be falsely positive with (high desturation index (DI)) with overnight oximetry or who have indeterminate overnight oximetry study.

CONFLICT OF INTEREST

The authors of this study reported no conflict of interest.

REFERENCES

1. Osada N. Sleep apnea syndrome: SAS. Nihon rinsho Japanese journal of clinical medicine. 2014; 72(8):1440-7.
2. Akasaka K, Akiba Y, Ishii Y, Fujiuchi S, Osanai S, Nakano H, et al. Association between sleep apnea syndrome and coronary artery disease. Nihon Kyobu Shikkan Gakkai zasshi. 1997;35(1): 16-21.
3. Walia R, Achilefu A, Crawford S, Jain V, Wigley SD, McCarthy LH. Are at-home sleep studies performed using portable monitors (PMs) as effective at diagnosing obstructive sleep apnea (OSA) in adults as sleep laboratory-based polysomnography (PSG)? The Journal of the Oklahoma State Medical Association. 2014;107(12):642-4.
4. Wu S, Wang R, Ma X, Zhao Y, Yan X, He J. Excessive daytime sleepiness assessed by the Epworth Sleepiness Scale and its association with health related quality of life: a population-based study in China. BMC Public Health. 2012;12:849-.

5. Berry RB, Budhiraja R, Gottlieb DJ, Gozal D, Iber C, Kapur VK, et al. Rules for scoring respiratory events in sleep: update of the 2007 AASM manual for the scoring of sleep and associated events. J Clin Sleep Med. 2012;8(5):597-619.
6. Nagata K, Osada N, Shimazaki M, Kida K, Yoneyama K, Tsuchiya A, et al. Diurnal blood pressure variation in patients with sleep apnea syndrome. Hypertension research : official journal of the Japanese Society of Hypertension. 2008; 31(2):185-91.
7. Valencia-Flores M, Orea A, Castano VA, Resendiz M, Rosales M, Rebollar V, et al. Prevalence of sleep apnea and electrocardiographic disturbances in morbidly obese patients. Obesity research. 2000;8(3):262-9.
8. Haines KL, Nelson LG, Gonzalez R, Torrella T, Martin T, Kandil A, et al. Objective evidence that bariatric surgery improves obesity-related obstructive sleep apnea. Surgery. 2007;141(3):354-8.
9. Osada N, Sekizuka H, Eguchi Y, Miyake F. [Sleep apnea and hypertension]. Nihon rinsho Japanese journal of clinical medicine. 2011;69(11):2030-6.
10. Ruehland WR, Churchward TJ, Schachter LM, Lakey T, Tarquinio N, O'Donoghue FJ, et al. Polysomnography using abbreviated signal montages: impact on sleep and cortical arousal scoring. Sleep medicine. 2014.
11. Quinnell TG, Bennett M, Jordan J, Clutterbuck-James AL, Davies MG, Smith IE, et al. A crossover randomised controlled trial of oral mandibular advancement devices for obstructive sleep apnoea-hypopnoea (TOMADO). Thorax. 2014;69(10):938-45.
12. Åkerstedt T, Lekander M, Petersen H, Kecklund G, Axelsson J. Sleep Polysomnography and Reported Stress Across 6 Weeks. Industrial health. 2014;52(1):36.
13. Fedson AC, Pack AI, Gislason T. Frequently used sleep questionnaires in epidemiological and genetic research for obstructive sleep apnea: a review. Sleep medicine reviews. 2012;16(6):529-37.
14. Cho YW, Lee JH, Son HK, Lee SH, Shin C, Johns MW. The reliability and validity of the Korean version of the Epworth sleepiness scale. Sleep and Breathing. 2011;15(3):377-84.
15. Hesselbacher S, Subramanian S, Allen J, Surani S, Surani S. Body mass index, gender, and ethnic variations alter the clinical implications of the Epworth Sleepiness Scale in patients with suspected obstructive sleep apnea. The open respiratory medicine journal. 2012;6:20.
16. Ghuman M, Ludwig MJ, St Anna L. Clinical Indicators of Obstructive Sleep Apnea. Clinical Inquiries, 2011 (MU). 2011.
17. Kendzerska TB, Smith PM, Brignardello-Petersen R, Leung RS, Tomlinson GA. Evaluation of the measurement properties of the Epworth sleepiness scale: a systematic review. Sleep medicine reviews. 2014;18(4):321-31.

....