Original Article

Is neck grasp a reliable screening tool for obstructive sleep apnea?

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Abstract:

BACKGROUND AND AIM: Determining patients at high risk for obstructive sleep apnea (OSA) via screening tools is important as undiagnosed OSA is associated with significant morbidities. The present study is aimed to determine the usefulness of easy sleep apnea predictor (ESAP) as a diagnostic tool for OSA.

METHODS: In this retrospective study, ESAP positivity was defined as the inability of the patients to wrap their necks with their own hands. The demographic, antropometric parameters, and polysomnographic values were compared between ESAP(+) and (−) groups.

RESULTS: The overall 287 OSA patients (47% severe) participated in this study. Patients in the ESAP(+) group (56.4%) showed higher rates of obesity and concomitant disease and also had increased neck, waist, and hip circumference, as well as more severe OSA (p<0.05). Multivariate regression analysis demonstrated that mild and severe OSA and obesity were independent predictors for ESAP positivity. The sensitivity, specificity, positive predictive value, and negative predictive value of ESAP negativity in AHI <5 (no OSA) were 73.7%, 61%, 22.4%, and 93.8%, respectively.

CONCLUSIONS: Although ESAP was not defined as a useful tool for the diagnosis of OSA, ESAP negativity can be used as a practical screening test in the primary care and outpatient clinics for excluding OSA.

Keywords:

Easy sleep apnea predictor, neck circumference, neck grasp, obstructive sleep apnea, polysomnography

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Introduction

Obstructive sleep apnea (OSA) is a common sleep disorder affecting 26% of the United States adult population and 32.8% in Brazil.[1,2]

The undiagnosed OSA accounts for 80% of the general population leading to many morbidities.[1,3–10] The diagnosis is via full night polysomnography (PSG) requiring laboratories, technicians, and board certificated doctors.[11] Many simple screen-

ing tests are frequently used.[12,13] The ability or inability of patients to wrap their own neck with their own hands has been defined as easy sleep apnea predictor (ESAP). However, current knowledge regarding the clinical use of ESAP is controversial.

The main risk factors for OSA are neck thickness, obesity, upper airway anatomy.[13–17] Thick neck leads to the decreased cross-sectional area for airway flow and promotes compliance and resistance against the airflow, the foremost factor contributing to OSA.[16,18,19] Recent two studies, with smaller sample sizes,[13,16] stated that ESAP can be used as a screening test, but another study from Ecuador[20] stated the contrary. In the literature, the gap in using ESAP as a screening test is to be highlighted.

In the present study, analyzing a considerably higher number of patients, we aimed to determine the usefulness of ESAP in predicting OSA.

Materials and Methods

This retrospective study reviewed the PSG records of 302 patients who were admitted to our accredited arbitrated PSG laboratory of the University of Health Sciences, Sureyyapasa Chest Diseases and Chest Surgery Education and Research Hospital to detect the presence of OSA between April 2019 and August 2019. Exclusion criteria were age under 18 years, a known upper airway obstruction pathology, total sleep duration less than 4 h based on PSG, absence of ESAP information in the record, and undetermined ESAP result such as <1 cm behind the nape posteriorly. Statistical analysis was achieved using SSPS 22 software.

The study was approved by the Institutional Review Board of our hospital (date: August 2019, number: 076).

The demographic parameters including age, gender, body mass index (BMI), smoking habit, waist and hip circumferences and waist to hip ratio, Epworth Sleepiness Scale, STOP-Bang Questionnaire, and concomitant diseases were recorded. The other important anthropometric parameter, thick neck, was determined according to the ability or inability of the patients to span their own neck with their own hands. The patients were asked to conjoin their own thumbs anteriorly and then to encircle their own neck using a scarf and the doctor

look the patient's nape if the middle digits appose to each other posteriorly. Increased neck circumference was diagnosed in case the digits of the patients' hands did not appose posteriorly and if at least 1 cm gap in between was present. Furthermore, increased neck circumference was accepted as ESAP positivity. The demographical characteristics and variables reflecting the breathing of the patients were analyzed and compared between patients according to having ESAP positivity and negativity.

The hip, neck, and waist were measured with a standard tape meter, recorded in centimeters. The neck circumference was measured when the patient stood erect, placing the tape below the laryngeal prominence and perpendicular to the long axis of the neck.

BMI was calculated as the weight (kg) corrected for the square of height (m²). BMI was classified as normal, overweight, obesity type 1, and obesity type 2 if the values were <25, 25–29.9, 30–34.9, >34.9 kg/m², respectively.

STOP-Bang Sleep Apnea Questionnaire has been a practical approach to screen for OSA.[8] STOP-Bang Questionnaire was rated according to the sum of "yes" answers given to the questionnaire. It consisted of eight questions including the presence of snoring, tiredness, observed apnea, hypertension, obesity (BMI ≥35 kg/m²), older age (>50 years), male gender, and neck circumference >40 cm. It was scored as high, intermediate, and low risk for OSA with the values having 5–8, 3–4, <2, respectively.[17]

The Epworth Sleepiness Scale has been the most frequently used screening test for assessing individual daytime sleepiness. It was consisted of eight questions including different daytime activities, such as reading a book in a sitting position, watching tv, sitting in a crowded population quietly, sitting back as a passenger in a car for more than an hour, lying for rest in the afternoon, talking with someone, after having a light lunch with no alcoholic beverages, and if the car stops for a few minutes. Each question was scored from 0 to 3. In these activities, the propensity was evaluated with a score of 10 points or more, indicating individual daytime sleepiness.[17,21]

The recorded PSG parameters were the average of the respiratory events including Apnea and Hypopnea Index per hour (AHI), mean AHI in the supine position (supine

AHI/h), mean AHI in the prone position (nonsupine AHI/h), mean AHI during the rapid eye movement (REM) phase of the sleep (REM AHI/h), mean AHI during the non-REM phase of the sleep (non-REM AHI/h), minimum oxygen saturation during the overnight sleep study (min sat 02) and the mean time spent with desaturation of <90%.[15,17]

Polysomnography

The PSG used in our institute was a standard diagnostic nocturnal overnight PSG having a 2- channel electrooculogram and a 3- channel electroencephalogram, a submental electrode for sleep stages, thermistor for oronasal airflow, pulse oximeter for oxygen saturation, two tibia elcetromyography for leg moments, abdominal and thoracic belts for chest wall, and abdominal motion (Comet, Gras, Astro Med, Inc., West Warwick, RI, USA). For the 2-channel electrooculogram and the 3-channel electroencephalogram, a submental electrode was used to determine sleep stages during PSG records and a nasal airflow catheter and a thermistor were used for intranasal pressure monitoring. Two tibia electromyography was used for leg movement records. Oxygen saturation measurement probe and chest and abdomen belts were used to provide ventilatory effort during respiration. The 2012 criteria of the American Academy of Sleep Medicine (AASM) was used for scoring.[11] Apnea was scored when there was a decrement in airflow of 90% or more lasting for at least 10 s. Hypopnea was defined when the airflow decrement of at least 30% was observed lasting more than 10 s, accompanied by oxygen desaturation of ≥3%. AHI score was defined with the average number of apnea and hypopnea per hour of sleep. The severity of OSA was categorized according to AHI and total respiratory events per hour, which is ≥5. AHI <5, classified as simple snoring, was not diagnosed as OSA. The severity of OSA was categorized as mild (AHI: 5.0–14.9 respiratory events/h), moderate (AHI: 15.0–29.9 respiratory events/h), or severe (AHI: >30.0 respiratory events/h).[11,15] All PSG examinations were interpreted by the three board-certified chest physicians.

Statistical analysis

Patients' characteristics were compared using Chi-squared, t-test, Mann–Whitney U tests for categorical, nonparametric, and parametric variables, respectively. The homogeneity of variances was approved by the inferential Levene test. The correlations between neck circumference with BMI and AHI were evaluated by Pearson's correlation test according to distribution assumptions. Multiple regression analyses were used to obtain the odds ratio (OR) for predicting ESAP positivity. To estimate OSA, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of ESAP were calculated.

Results

Overall 287 patients (mean age of 48.36 years with 72.8% male) were enrolled in this study. Among all patients, 56.4% of patients (n=162) were ESAP positive. The most common comorbidities were hypertension (32.1%), diabetes mellitus (24.4%), and asthma (19.2%). The median BMI was 31.8 kg/m2. The prevalence of OSA by PSG was classified as mild (17.8%, n=51), moderate (22%, n=63), severe OSA (47%, n=135), and 13.2% (n=38) were classified as not having OSA disease. The patient distribution according to STOP-Bang Questionnaire was 2.4% (n=7) mild, 10.1% (n=29) moderate, and 87.5% (n=251) severe. Of the patients, 9.1% had normal weight, whereas 26.1% were overweight, 35.2% were obese type 1, and 28.9% were obese type 2 due to BMI classification (Tables 1, 2).

The comparison of ESAP positive and ESAP negative groups according to age, BMI classification, neck circumference, waist circumference, hip circumference, smoking habits, severity of OSA, STOP-Bang Questionnaire results, hypertension, and diabetes mellitus was found statistically significant (p<0.001).

The difference between the groups was significant in terms of all PSG results (p<0.001) (Table 2). In the ESAP positive group, all sleep-disordered breathing parameters were found to be worse than those in the ESAP negative group.

There was a significant correlation between neck circumference and BMI (r=0.512, p<0.001) and AHI (r=0.403, p<0.001). Also, there was a significant correlation between AHI and BMI (r=0.329, p<0.001), neck circumference (r=0.403, p<0.001), and waist–hip ratio (r=0.216, p<0.001). In the analysis of examining the independent predictors of ESAP positivity, the OR (CI 95%) for BMI classes were 2.20 (0.61–7.92), p=0.226; 5.80 (1.60–21.01), p=0.007; and 28.62 (6.49–126.22), p<0.001, in the overweight; obese type 1; and obese type 2, respectively. The OR (CI 95%) for AHI classes were found to be 3.79 (1.16–12.37), p=0.027; 2.72 (0.84–8.74), p=0.092; and 3.62

Table 1: Patient characteristics according to ESAP status

Parameters	Total (n=287)	ESAP negative (n=125)	ESAP positive (n=162)	p
Mean age (years)	48.36±10.78	45.39±10.9	50.65±10.14	<0.001
Mean BMI (kg/m²)	32.47±6.31	29.04±4.20	35.12±6.39	<0.001
BMI, normal (<25 kg/m²) (%)	9.1	17.7	2.5	<0.001
BMI, overweight (25–29.9 kg/m²) (%)	26.3	41.9	14.3	
BMI, obese type 1 (30–34.9 kg/m²) (%)	35.4	32.3	37.9	
BMI, obese type 2 (>35 kg/m²) (%)	29.1	8.1	45.3	
Smoking (pack/year)	15.35±22.56	12.21±19.86	17.78±24.23	<0.001
Neck circumference (cm)	41.91±3.66	40.65±3.32	42.88±3.62	<0.001
Waist circumference (cm)	113.56±13.42	107.4±12.09	118.31±12.45	<0.001
Hip circumference (cm)	115.7±13.74	109.29±10.97	120.64±13.65	<0.001
Gender (male, %)	72.8	76.8	69.8	0.18
STOP-Bang mild (<2) (%)	2.4	5.6	0	0.005
STOP-Bang moderate (3–4) (%)	10.1	12.0	8.6	
STOP-Bang high (5–8) (%)	87.5	82.4	91.4	
Epworth Sleepiness Scale	7.3±4.98	6.82±4.87	7.67±5.04	0.14
Systemic hypertension (%)	32.2	17.6	43.5	<0.001
Diabetes mellitus (%)	24.4	13.6	32.7	<0.001
No OSA (AHI <5) (%)	13.2	22.4	6.2	<0.001
Mild OSA (AHI: 5–14.9) (%)	17.8	19.2	16.5	
Moderate OSA (AHI: 15–29.9) (%)	22	24	20.4	
Severe OSA (AHI ≥ 30) (%)	47	34.4	56.8	

ESAP: Easy sleep apnea predictor, BMI: Body mass index, OSA: Obstructive sleep apnea, AHI: Apnea and Hypopnea Index

(1.09–11.94), p=0.035, respectively. The OR for neck circumference was 1.08 (096–1.21), p=0.196.

The sensitivity, specificity, PPV, and NPV of ESAP negativity in AHI <5 (no OSA) group were found to be 73.7%, 61%, 22.4% 93.8%, respectively (Table 3).

The sensitivity, specificity, PPV, and NPV were 52.4%, 73.9%, 72.9%, and 53.8%, respectively, in mild OSA. In moderate OSA, values were 49.2%, 73.7%, 76.7%, 48.3%, respectively, and in severe OSA, they were 68.1%, 73.7%, 90.1%, 39.4%, respectively (Table 4). The receiver operating characteristic analysis was not performed as ESAP was a categorical variant.

Discussion

This current study presents that ESAP cannot be defined as a reliable screening test for OSA diagnosis and OSA severity categorization. Our key finding emphasizes ESAP negativity in excluding OSA disease with higher sensitivity, moderate specificity, and highest NPV. Thus, ESAP negativity can serve as a practical tool for receding from OSA for physicians working in primary healthcare facilities and outpatient clinics. In the comparison of screening tests, we demonstrated that ESAP positivity is superior to increased neck circumference, supporting the neck grasp for alternative neck circumference measurements, but inferior to BMI.

Table 2: Comparison of variables reflecting sleep-disordered breathing according to ESAP status

Variables	Total (n=287)	ESAP negative (n=125)	ESAP positive (n=162)	p
AHI (mean±SD)	33.2±25.67	26.78±24.49	38.15±25.53	<0.001
Supine AHI (mean±SD)	43.75±31.52	36.38±30.92	49.44±30.89	<0.001
Nonsupine AHI (mean±SD)	23.1±25.24	15.96±21.98	37.53±25.89	<0.001
REM AHI (mean±SD)	30.15±27.73	24.57±23.11	34.45±30.2	0.02
Non-REM AHI (mean±SD)	32.74±26.07	26.54±25.07	37.53±25.89	<0.001
Minimum SaO$_2$ (mean±SD)	74.7±13.65	77.49±12.24	72.54±14.31	<0.001
SaO$_2$ time <90% of the time (mean±SD)	18.4±23.2	11.97±15.23	23.35±26.85	<0.001

ESAP: Easy sleep apnea predictor, AHI: Apnea and Hypopnea Index; SD: Standard deviation, REM: Rapid eye movement,

Table 3: Sensitivity, specificity, PPV, and NPV of each screening test for no OSA group

Screening test	AHI <5 (n=38)			
	Sensitivity	Specificity	PPV	NPV
ESAP	73.7	61	22.4	93.8
Neck circumference	60.5	53.4	16.5	89.9
BMI	54.1	67.3	19.8	90.8

PPV: Positive predictive value, NPV: Negative predictive value, OSA: Obstructive sleep apnea, ESAP: Easy sleep apnea predictor, BMI: Body mass index

In two of the previous studies of Edmonds et al.[13,16] with small sample sizes, neck grasp was indicated as a screening test in predicting OSA, with 100% specificity, but a sensitivity of 55%. One of these two studies consisted of only individuals with diabetes mellitus. Another study by Del Brutto et al.[20] from Ecuador, as mentioned earlier, with a smaller sample size included in the Amerindian ethnicity, found that ESAP was not a predictor of OSA with a sensitivity of 83% and a specificity of 39.6%. Ethnicity was mentioned and designed as a door-to-door survey only in this study. All of these three studies were restrospective. Our study, similar to the study from Ecuador, demonstrated that ESAP was not a predictor of OSA. Unlikely, our study was a retrospective one, not choosing one ethnicity.

The other most striking finding of our study was BMI was not only a "perfect fit" for the screening test and superior to other screening tests but also found to be a predictor of ESAP. In the literature, obesity and neck circumference were indicated as risk factors for OSA.[22–29] Katz et al.[25] stated that neck circumference and the degree of obesity are important predictors of OSA. Also, Alice et al.[22] stated that neck circumference–height ratio can be

included as a simple screening tool for OSA in children. In another study examining patients with COPD,[24] the predictors were distinct from OSA in the general population, for example, larger neck circumference and male gender were not associated whereas BMI ≥25 kg/m² and the presence of cardiovascular diseases were associated with OSA.[24] Obesity in the OSA pathophysiology is well established.[27,28] In our study, there was a strong association between BMI and AHI, and in the analysis of independent predictors of ESAP positivity, the OR for each increasing BMI value was also increased. ESAP positivity had a strong correlation with all OSA subgroups with the first and foremost severe OSA. The most striking result was the highest OR ratio for the obese type 2 group. It was similar to the earlier neck grasp studies.[16,19,21]

In the literature, neck circumference was reported to be more predictive than obesity.[17–19,22–26] In our study, the mean neck circumference showed a significant difference in the ESAP positivity. In the comparison of screening tests in identifying OSA, neck circumference was found to be not superior to BMI, probably reflecting the characteristics of patients with high BMI being referred to a sleep laboratory.

The relationship between OSA and metabolic syndrome is well described in the literature.[28,29] Similarly, in our study, systemic hypertension and diabetes mellitus demonstrated a statistically significant difference in ESAP positive patients with increased neck circumference. Beyond the effects of obesity, leading to mass accumulation in the neck radius compressing the upper airway and promoting the airflow resistance, the effects of intermittent hy-

Table 4: Comparison of screening tests for sensitivity, specificity, PPV, and NPV for each OSA severity

Screening tests for each OSA severity	Sensitivity	Specificity	PPV	NPV
Mild OSA				
ESAP (+)	52.9	73.7	72.9	53.8
Neck circumference	41.2	60.5	58.3	43.4
BMI ≥30	56.9	54.1	63	47.6
Moderate OSA				
ESAP (+)	52.4	73.7	76.7	48.3
Neck circumference	49.2	60.5	67.4	41.8
BMI ≥ 30	54	54.1	66.7	40.8
Severe OSA				
ESAP (+)	68.1	73.7	90.1	39.4
Neck circumference	60	60.5	84.4	29.9
BMI ≥30	77.6	54.1	86	40

PPV: Positive predictive value, NPV: Negative predictive value, OSA: Obstructive sleep apnea, ESAP: Easy sleep apnea predictor, BMI: Body mass index

poxia promoting the release of inflammatory mediators were possibly involved in the pathophysiology.[16,28,29]

The strength of our study resides in the larger sample size. Because our hospital is a third referral hospital and our sleep laboratory is accredited arbitrated, the social insurance conduct patients to hand down a decision from a different region with different ethnicity. The screening test must fit every different ethnicity and region with high power.

The limitation of our study includes: it is a retrospective chart review study, and neck grasp test results are not present in all records, leading to a small studied population and failing to conclude why patients cannot do the test and the selection bias. Because our hospital is a third referral hospital, mainly severe OSA patients were admitted. The inability to perform the receiver operating characteristic analysis leads to an unevaluation of test performance. In our study, STOP-Bang Questionnaire and Epworth Sleepiness Scale were also performed in all patients but were not included in the comparison of the screening tests in between for various reasons. First, our institution is a tertiary healthcare institution for chest diseases where the patients are already previously evaluated by at least one chest physician and referred to our sleep outpatient clinic. Therefore, referral and selection biases limit the results and generalizability of our study population consisting mostly severe patients, leading to relatively small number of patients in the control group. Second, STOP-Bang Questionnaire found only seven patients in the mild and moderate OSA group and the rest of the patients in the severe OSA group, misleading the results. Finally, the majority of the patients included in the study neither had a driving license nor a car, which also made the test unreliable. As pointed out earlier, Epworth Sleepiness Scale was disappointing due to literacy.[21]

It must be emphasized that the best screening test to evaluate the likelihood of having a particular disease commonly has a higher sensitivity, with a higher PPV and NPV with a moderate specificity.[30,31] As ESAP positivity did not fulfill these criteria, it should not be used in OSA diagnosis. It must be emphasized that new cost-effective and time-saving screening tests are needed. This study highlights that ESAP negativity or normal neck circumference is a good screening test for excluding the OSA for having high sensitivity and displaying an easier use in primary care settings than sleep clinics, especially in a country with different ethnicity, low income, and high health income. Besides, ESAP negativity was not enough for patients with symptoms and comorbidities related to OSA, and we should not exclude OSA without negative PSG test results.

In conclusion, ESAP positivity or neck grasp cannot be defined as useful tools for the diagnosis of OSA or the severity of the disease. However, in a country with different ethnicity, low income, and high health expenditure, ESAP negativity can be used as a screening test in the primary care and outpatient clinics for receding from OSA.

Conflicts of interest
There are no conflicts of interest.

Ethics Committee Approval
The study was approved by The University of Health Sciences Sureyyapasa Chest Diseases and Chest Surgery Training and Research Hospital Institutional Review Board Ethics Committee (No: 076, Date: 21/08/2019).

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