

A Pilot Study of the Inability to Fit Hands Around Neck as a Predictor of Obstructive Sleep Apnea

Peter J Edmonds, Lee C Edmonds¹

SUNY Upstate Medical University, Syracuse, ¹Basset Medical Center, Sleep Disorder Center, Bassett Research Institute
Cooperstown, NY, USA

Abstract

Background: Considering the high estimates of undiagnosed and untreated obstructive sleep apnea (OSA), there is a need for simple and accurate diagnostic tests. Neck circumference has long been correlated with OSA, but its usefulness as a diagnostic tool has been limited. **Aims:** We proposed to evaluate the value of a simple neck grasp test to help identify OSA. We hypothesized that the inability of a patient in a sleep clinic to fit their hands around their neck is predictive of OSA. **Materials and Methods:** A retrospective review of medical records of patients evaluated in a general sleep clinic was performed. Easy sleep apnea predictor (ESAP) positive was defined as the inability to place the hands around the neck with digits touching in the anterior and posterior. ESAP negative was the ability to place hands around the neck. Positive for OSA in this symptomatic sleep clinic population was defined as an apnea-hypopnea index (AHI) of ≥ 5 . **Results:** A total of 47 subjects (36% female) had ESAP data available, which were reviewed. The mean age was 51.6 years (SD 14.4, range 29-81 years). The mean body mass index (BMI) was 38.8 (SD 9.9, range 20.4-69.5). Review showed 87.2% ($N = 41$) tested positive for OSA by AHI of ≥ 5 . The sensitivity and specificity of ESAP were 68.3% and 100%, respectively. The positive predictive power was 100% and the negative predictive power was 31.6%. **Conclusion:** As we hypothesized, ESAP positive (inability to span neck) was predictive of OSA in a population of sleep clinic patients. An ESAP positive test was 100% predictive of the presence of OSA (AHI of ≥ 5). ESAP shows promise for ease of clinical use to predict the presence of OSA in a general sleep clinic population.

Keywords: Diagnostic tool, easy sleep apnea predictor (ESAP), neck size

Address for correspondence: Mr. Peter J Edmonds, One Atwell Road, Cooperstown, New York - 13326, USA.
E-mail: edmondsp@upstate.edu

Introduction

Obstructive sleep apnea (OSA) is a chronic condition that affects 3-7% of the population.^[1] Despite increasing public awareness over the last 20 years, OSA is still underdiagnosed and untreated.^[2,3] The negative health consequences of untreated sleep apnea continue to be elucidated, but currently include significant morbidity-related entities such as cardiovascular disease, hypertension, and abnormal glucose metabolism.^[4-6] More readily available and cost-effective methods of

diagnosing OSA could have significant impact on public health and reduce health-care expenditures.

Factors known to increase risk of OSA include neck size, age, male sex, obesity, family history, and craniofacial anatomy.^[7] Upper airway anatomy is involved in the pathophysiology of OSA. Decreased cross-sectional area and increased compliance of the upper airway contribute to OSA.^[8] Neck mass constitutes a dynamic load placed

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on the airway. Neck circumference measurement reflects neck tissue mass and serves as a surrogate measure of neck mass. External neck circumference has been shown to have better correlation to apnea-hypopnea index (AHI) than did the measure of body mass index (BMI).^[9,10] Neck circumference corrected for by height is more useful.^[11]

In 1990, Katz *et al.* published an article entitled “Do Patients with Obstructive Sleep Apnea Have Thick Necks?”^[9] Our study restates the question to read, “Do patients with thick necks have obstructive sleep apnea?” We hypothesized that a simple and objective test using proportionate neck size (subject spanning their own neck with their own hands) rather than measured circumference would simplify the screening and increase the recognition and diagnosis of OSA. This simple objective maneuver may eliminate the need to rely on first- and third-person subjective reporting of snoring quality, possible apnea, sleep quality, and sleepiness that is currently heavily relied upon for suspicion of OSA. We evaluated a simple neck grasp maneuver as a predictor of OSA in a general sleep clinic.

Materials and Methods

The Institutional Review Board at Bassett Medical Center approved this retrospective chart review and waived the need for informed consent from patients. A retrospective review of charts was performed to obtain the following data: ESAP status, age, gender, BMI, and polysomnogram/home sleep test (PSG/HST) result. Fifty consecutive adult patients (aged >18 years) requiring PSG for clinical evaluation were assessed with the easy sleep apnea predictor (ESAP) test [Figure 1] at the time of the consultation. The patients were instructed to place their thumbs together at the anterior neck and to wrap their fingers around their neck until they met in the posterior. A positive ESAP test was defined as the inability to easily (without excess squeezing and choking) encircle the neck completely [Figure 2]. A negative ESAP test was defined as the ability to easily encompass their hands around the neck [Figure 3]. The result of the ESAP test was recorded in the medical record as positive or negative. Clinical testing with PSG or HST level 3 was dictated by the consulting clinician’s clinical determination and insurance coverage. PSG was performed and scored according to current the American Academy of Sleep Medicine (AASM) guidelines.^[12] In medicare patients ($N = 7$), the hypopnea definition of 30% reduction in flow with 4% desaturation was applied; all others were scored using the 30% reduction with either a 3% desaturation or an arousal. HST ($N = 1$) was performed and scored by manufacturer’s setting and reviewed and interpreted by a Board Certified Sleep Physician. For the purpose of the main study



Figure 1: The easy sleep apnea predictor is performed by touching the thumbs in the anterior of the neck and encircling the neck with the digits in the posterior

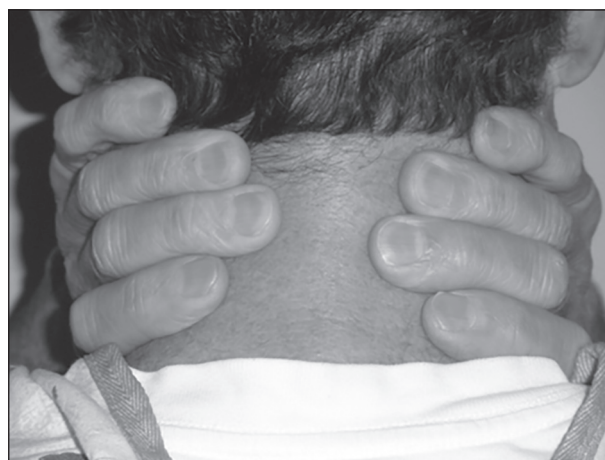


Figure 2: Easy sleep apnea predictor positive is the inability to easily encircle the neck so that the patient’s digits meet on the posterior neck



Figure 3: Easy sleep apnea predictor negative is the ability to encircle the neck without excessive choking with digits touching at the posterior neck

analysis, OSA was defined as an AHI of ≥ 5 . Subanalyses were conducted using AHI cutoffs of AHI of >10 and AHI of >15 .

Statistical analysis

Demographic variables were compared between ESAP positive and ESAP negative patients using Chi-square (for gender) and the *t*-test (for BMI, age, and AHI). Using AHI as the gold standard for OSA diagnosis, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of ESAP to predict OSA were calculated. Sensitivity, specificity, PPV and NPV of obesity classes (BMI ≥ 30 and BMI ≥ 35) to predict OSA were also calculated.

Results

A total of 47 subjects (36% female) underwent sleep testing. Three of the initial 50 patients did not have confirmatory testing. Two of the 47 subjects had HST rather than PSG by insurance requirement [Table 1]. The mean age was 51.6 years (SD 14.4, range 29-81). The mean BMI was 38.8 (SD 9.9, range 20.4-69.5). In our population, 87.2% ($N = 41$) tested positive for OSA by AHI of ≥ 5 . The median AHI was 37.4.

ESAP did differentiate a statically significant difference in the population for AHI ($P < 0.001$) and BMI ($P < 0.001$) [Table 2]. Both AHI and BMI were significantly greater on average for ESAP positive subjects as compared to ESAP negative subjects. Between the ESAP positive and negative groups there is no statistical difference for gender ($P = 0.49$) or age ($P = 0.66$) [Table 2].

The sensitivity and specificity of ESAP were 68.3% and 100%, respectively, with regard to an AHI of ≥ 5 . The positive predictive power was 100% and the negative predictive power was 31.6% for an AHI of ≥ 5 . Using BMI to predict AHI of ≥ 5 revealed weaker prediction. The PPVs for BMI ≥ 30 and BMI ≥ 35 were 92% and 90%, respectively, at an AHI of ≥ 5 . The PPVs of ESAP remained similar when stratified by BMI >30 and BMI >35 for three levels of AHI (≥ 5 , >10 , and >15) [Table 3]. The PPV decreased as the AHI threshold was increased [Table 3].

Discussion

The field of sleep medicine is working to improve the diagnosis and treatment of OSA in a cost-effective manner; it is estimated that 80% of the people with OSA are undiagnosed. Incorporating novel methods will be required to successfully meet these demands. Over the past decade, many screening algorithms and questionnaires have been developed such as

Table 1: Characteristics and demographics of the study population

Sex	36% female ($N = 17$)
Mean age	51.6 years (SD 14.4, range 29-81 years)
Mean BMI	38.9 \pm 9.9
Median AHI	37.4
ESAP status	59.6% positive
AHI ≥ 5	87% ($N=41$)

SD = Standard deviation, BMI = Body mass index, AHI = Apnea hypopnea index, ESAP = Easy sleep apnea predictor

Table 2: A comparison of ESAP negative and positive patients for BMI, AHI, age, and gender

	ESAP negative [*]	ESAP positive [†]	P
	N = 19 (40.4%)	N = 28 (59.6%)	
BMI (mean \pm SD)	32.0 \pm 6.8	43.3 \pm 9.1	<0.001
Median	30.6	40.8	
Range	20.4-49.7	27.5-69.5	
AHI (mean \pm SD)	18.6 \pm 21.7	46.8 \pm 34.5	<0.001
Median	9.0	38.0	
Range	0-72.0	5.0-132.0	
Age (mean \pm SD)	50.5 \pm 15.4	52.4 \pm 14.0	0.66
Median	44.0	49.0	
Range	33.0-81.0	29.0-73.0	
Gender			
Male	11 (57.9)	19 (67.9)	0.49
Female	8 (42.1)	9 (32.1)	

SD = Standard deviation, BMI = Body mass index, AHI = Apnea hypopnea index, ESAP = Easy sleep apnea predictor, ^{*}ESAP negative: The ability to encircle the neck without excessive choking with digits touching at the posterior neck, [†]ESAP positive: The inability to easily encircle the neck so that the patient's digits meet on the posterior neck

Table 3: Positive predictive value of easy sleep apnea predictor analyzed by BMI and AHI

AHI ≥ 5		
BMI >30 ($N=38$)	AHI ≥ 5 ($N=35$)	PPV 92
BMI >35 ($N=33$)	AHI ≥ 5 ($N=30$)	PPV 90
ESAP positive [*] ($N=28$)	AHI ≥ 5 ($N=28$)	PPV 100
AHI >10		
BMI >30 ($N=38$)	AHI >10 ($N=29$)	PPV 76
BMI >35 ($N=33$)	AHI >10 ($N=24$)	PPV 73
ESAP positive ($N=28$)	AHI >10 ($N=24$)	PPV 86
AHI >15		
BMI >30 ($N=38$)	AHI >5 ($N=25$)	PPV 65
BMI >35 ($N=33$)	AHI >15 ($N=22$)	PPV 66
ESAP positive ($N=28$)	AHI >15 ($N=22$)	PPV 79

AHI = Apnea hypopnea index, BMI = Body mass index, ESAP = Easy sleep apnea predictor, ^{*}ESAP positive: the inability to encircle the neck by hand grasp

STOP-BANG and the Berlin Questionnaire. None are as simple and as easily applied as the proposed ESAP test.

Obesity and a large neck have long been established as risk factors for OSA.^[9,10] To our knowledge, this is the first time that this well-recognized fact has been leveraged in a simple neck grasp maneuver, as a diagnostic tool for OSA. Our retrospective pilot data support our hypothesis that a positive ESAP, the inability to fit hands around the neck, strongly correlates with OSA in a general sleep clinic population and this correlation is superior to BMI alone.

ESAP's usefulness is consistent with the known fact that neck size predicts OSA^[7,9,10,12] and that proportionate data, corrected for body size, are more valuable than absolute measurements.^[13] ESAP is more easily applicable than linear measure, and it does not require the adjustments for gender required with linear measure.^[14,15]

Our finding of 100% PPV of the ESAP maneuver in diagnosing OSA is remarkable. We would like to point out several contributing factors, which need comment. First, we recognize that our threshold for presence of OSA was low (AHI of ≥ 5). However, in a symptomatic sleep clinic population, this is arguably an appropriate set point for consideration of treatment. When the threshold for OSA was increased to AHI of >15 , our data showed that the PPV of ESAP to remain clinically useful at 86%. This was superior to the predictive power of the objective measure of BMI. We did not evaluate ESAP combined with any other parameter or test such as snoring, observed apnea, presences of hypertension, or Epworth Sleepiness Scale. This raises the second point of note that the high pretest probability of this "preselected" referral population improved ESAP predictive power. This selection bias needs recognition in the application of ESAP. This does not reduce the value of the ESAP test when applied to this population. The final point of comment on the 100% PPV pertains to an issue that needs to be clarified for the entire field of sleep medicine, not just our ESAP validity; that is the definition of sleep disordered breathing events, namely hypopneas. Our retrospective "real world" analysis includes patient scored with both the 2007 and 2014 definitions of hypopneas. The more recent 2014 definition lowers the threshold for diagnosing OSA and hence increases the PPV of ESAP. This does not stand to negate ESAP positive value, but needs to be recognized. This terminology issue was well articulated by Krakow *et al.*^[16] and Collop;^[17] we are not attempting to bring any additional clarity to the definitions other than to say that the ESAP data stands in the midst of this change in terminology.

The most obvious and important limitation of the ESAP test is the rate of false negatives, NPV of 31.6%. The lack of value of a negative ESAP needs recognition when the ESAP is applied. A negative ESAP certainly does

not exclude OSA. The standard testing (PSG or HST) is still required if clinically indicated in an ESAP negative patient. Other factors, such as craniofacial anatomy and upper airway anatomy, contribute to OSA regardless of neck size and ESAP negativity. That point understood, the positive ESAP remains valuable at identifying the 80% of patients with undiagnosed OSA, the majority of whom are obese and likely ESAP positive.

Another value of ESAP is its objective nature. In our population, the equally objective measure of BMI was inferior [Table 2] to ESAP over a range of AHI. ESAP is arguably the simplest of all objective tests, requiring only seconds of clinical time and no device. This heightens its value in simple recognition of patients at risk for OSA. In unique populations, such as commercial drivers, this objective screen might prove invaluable to highway safety; however, to date this population has not been evaluated.

ESAP may hold significant financial health-care implications. First, the general economic burden to society of untreated OSA remains high despite three decades of recognition of the syndrome.^[18] Second, the health-care expenditure for untreated OSA is estimated at \$3.4 billion in the US.^[19] The initial step in addressing this economic problem is improving diagnosis, which ESAP appears every effective in the sleep clinic population. Lastly, ESAP may result in a cost reduction in the area of diagnostic testing to identify OSA by reducing reliance on PSG.

Conclusion

As we hypothesized, ESAP positive (inability to span neck) was predictive of OSA. ESAP shows promise for ease of clinical use to predict the presence of OSA in a general sleep clinic population. Further research to evaluate this simple stand-alone diagnostic maneuver is warranted to confirm the high predictive value in this and other populations. The process of disease recognition of OSA remains a challenge and ESAP may prove to be the easiest and least expensive tool available.

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Conflicts of interest

The authors have no conflicts of interest including financial support, or involvement with organizations that have a vested financial interest.

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